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MACHINE-TOOL PRACTICE FOR MAXIMUM PRODUCTION

By Charles Day.

The article under the above title in the July issue summarized present practice regarding certain of the principal factors that have revolutionized the art of metal working and methods of shop administration. It was stated that the knowledge acquired concerning the requirements of the work and properties of the cutting tool, together with the standardization of many shop details, is but just forming a thoroughly sound basis for machine-tool design and operation. This installment will consider matters bearing more specifically upon the design, construction, and operation of machine tools.—THE EDITORS.

IT must be remembered that in order to secure, during practical operation, the highest efficiency of the machine tools described below, the small-tool equipment must be properly cared for and a system of management enforced that provides, for each operator, directions concerning the adjustments of his machine for various jobs, and that also assures continuous movement of the parts to be machined until they are finished.

I preface this article with the foregoing remarks, as machine-tool design is no longer confined to a mere knowledge of the principles of mechanics and the properties of materials, any more than the services of the industrial engineer, engaged to prepare plans for a new machine-shop building, have to do only with the structural and architectural details that ultimately compose the building plans. An understanding of the fundamental laws underlying pure machinery design (which as a matter of fact are useful only provided the work to be done can be accurately defined) is constantly becoming the more simple part of the total information that is necessary for the designer to possess, especially as these laws are expressed in mathematical formulæ and permit of only one interpretation. It is rather his grasp of the more subtle considerations arising through a knowledge of the

subjects considered in the previous paper that measures his ability to cope successfully with the problems modern conditions have introduced. The men who lead in this field have good insight into the readiness of those who purchase machine tools to adopt departures in design and methods of operation that make for greater output, and one of the principal problems with which they are confronted is to educate the trade as rapidly as they can perfect their machines.

The questions before us may be properly divided under two headings; first, the definition of range and character of work to be performed; second, design and construction suitable for the fulfilment of specified requirements.

Radical changes in design have been brought about principally through the efforts of machine-tool builders to meet given requirements in a more efficient manner by limiting the range of usefulness of their machines, and secondarily, after the duty has been fixed, to provide means that will permit of the most efficient utilization of the high-speed steels. It is obvious that the designer must be guided almost wholly by his own judgment when arriving at a decision concerning the range of work that a given machine should handle. Much more definite data, however, are available concerning the performance of cutting tools, for the records that have been secured and the standards that have been established by machine-tool builders and the concerns manufacturing tool steel are now so complete that their maximum capabilities can be foretold within reasonable limits.

The relations existing between cutting speed, feed, depth of cut, and power requirements for various machining operations with high-speed tools when working upon different kinds of materials, are now so well understood that slide rules have been made which greatly facilitate accurate work of design. The bearing these factors have upon the power demand was referred to briefly in the preceding article under the heading of motor drives.

Mr. Fred W. Taylor's admirable treatise entitled "The Art of Cutting Metals" is deserving of the most careful study upon the part of machine-tool designers, for it not only contains data that are of immediate usefulness, but points the way for further advances through the continuance of experimental work in the same thorough and scientific manner. The metallurgical side of the subject should also be familiar to those directly engaged in the advancement of machine-shop practice, and its present status is well covered by Mr. O. M. Becker in his articles that recently appeared in this magazine.

As a result of the thorough study given to all of the foregoing matters, there is a marked tendency toward the grouping of machine

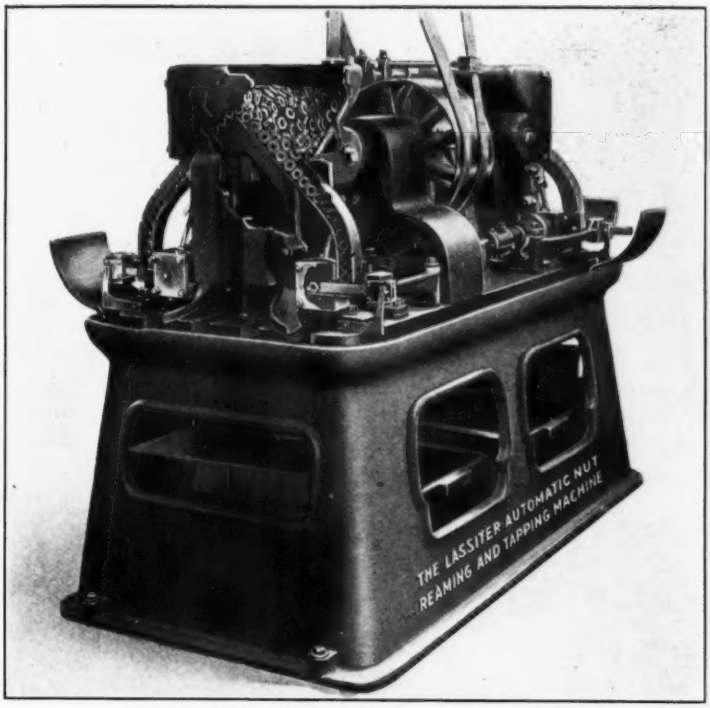


FIG. 1. LASSITER AUTOMATIC NUT-TAPPING MACHINE.

tools into three broad classes; 1, fully or partially automatic machines; 2, machines of small range with limited functions; and 3, machines of broad usefulness characterized by the perfected designs of older types.

The full automatic machine tool reaches the highest efficiency in so far as facility of operation enters in, and this is a matter of much more importance than formerly as the knowledge of the most efficient method of performing each of possibly a great number of operations, necessitates constant changes in feeds and speeds. The Lassiter automatic nut-tapping machine (Figure 1) is one of the most recent examples of this type. It is hardly necessary to point out that except for the general attention that must be given to any automatic machine, it is necessary for the attendant only to put the nut blanks into the receiving hopper and take away the finished product. One of these machines in the Schenectady works of the American Locomotive Company operated during a week's run at the rate of 12,000 ½-inch

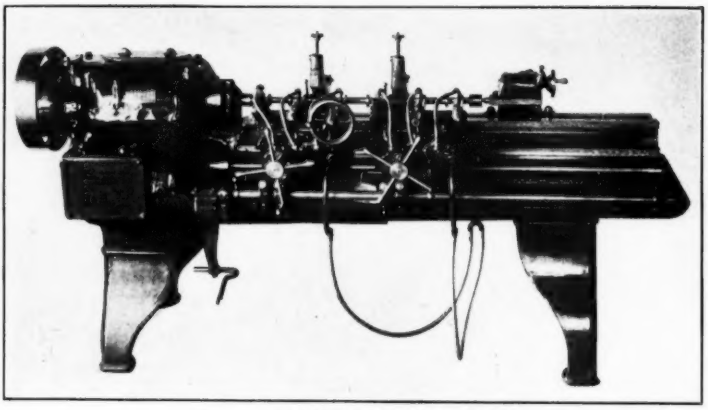


FIG. 2. FITCHBURG LO-SWING LATHE.

nuts in ten hours, and in the same period 10,000 5/8-inch nuts. The machine in question is designed to tap and ream nuts up to 1⅛ inch. Of course, if one of the spindles is reaming and the other tapping the above output would be halved.

The field of usefulness and efficiency of the full automatic machines made by the Brown & Sharpe Manufacturing Company, the National Acme Manufacturing Company, and others is so well understod as not to require emphasis here. The same holds true of the semi-automatic machines of the Jones & Lamson, Potter & Johnson and Gisholt types, for all these have demonstrated their efficiency beyond question of doubt.

The "Lo-Swing" lathe (Figure 2) built by the Fitchburg Machine Works is a good illustration of the class of machines designed for a small range of work and, in this case, for the performance of but a single function, namely, turning on centers. The maximum diameter of work that it will handle is 3½ inches, and it is not available for chucking work or for screw cutting or any purpose other than plain turning. This limitation of duty permits of very great rigidity of construction, a condition necessary for the performance of accurate work at high speed. Space will not allow of the description of interesting points that this lathe incorporates, such as the manner of rigidly supporting the work, the tool carriages, etc. It is now generally conceded that the maximum output of a lathe is secured by taking the coarsest feed consistent with the work to be done, and owing to the limited range of the Lo-Swing design combinations of feed and speed can be had that represent almost maximum efficiency for any possible condition. The driving mechanism is designed to provide

power necessary for the performance of any reasonable roughing work falling within the lathe's capacity, so that the cutting tool has been made the limiting factor.

The value of narrowing down the available range of work can be illustrated by citing certain performances of a Lo-Swing lathe. Cam shafts having eight cams and one gear to each shaft (for four-cylinder gas engines for automobile operation) were turned from the solid steel bar in one hour each, four tools being operated at the same time. The record for this job when done on an engine lathe was several times as long. In another instance cast-steel steering knuckles used on automobiles were turned and the shoulders faced at the rate of 200 per day of 10 hours, or 3 minutes each. Ordinarily these parts, if machined on the usual type of engine lathe, would require about 10 to 15 minutes apiece. In both cases the work was done without the use of any special tools or attachments other than those furnished with the machine. I regret that it is not possible to include detail dimensions of the parts referred to.

The Lassiter straight or taper bolt-turning machine (Figure 3) was also designed for a limited range of work and for a specific function. Latest practices have been taken advantage of and its output, in practical everyday production, of 1,762 ¾-inch to ⅞-inch taper bolts 4 inches long in 10 hours (spindle speed 75 revolutions and 5/32-inch feed per revolution) and 304 2-inch bolts 16 inches long in the same time (spindle speed 40 revolutions and feed 5/32-inch per revolution) are a good

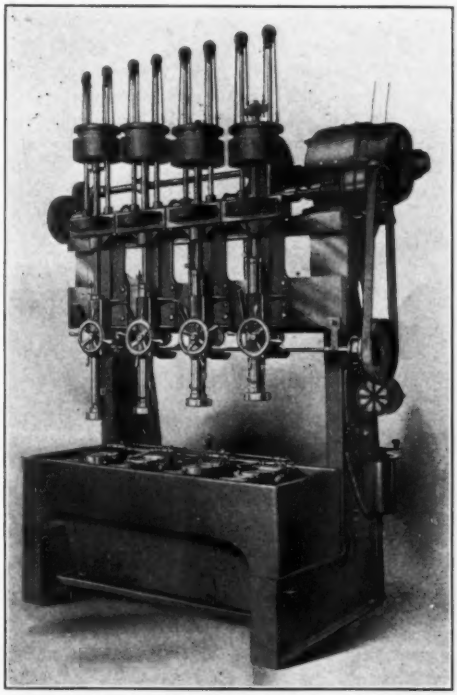


FIG. 3. LASSITER STRAIGHT AND TAPER BOLT-TURNING MACHINE.

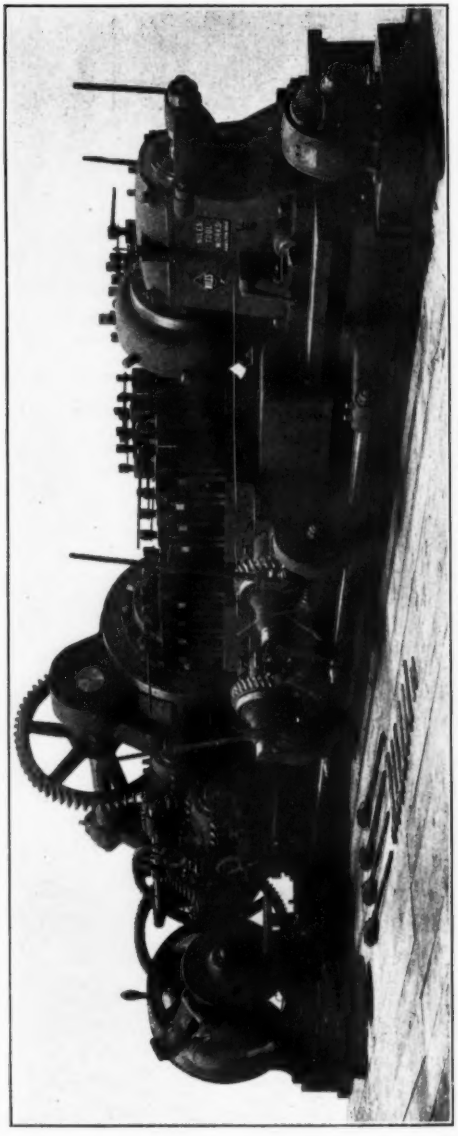


FIG. 4. NILES INGOT-SLICING LATHE.

indication of the efficiency of the result. The foregoing production is secured by roughing on two spindles and finishing on the two others.

The single-purpose principle is also exemplified for machines of a much larger class by the Niles ingot-slicing lathe (Figure 4). It is provided with sixteen cutting tools, eight on the front and eight on the rear of the machine, and each pair of front and rear tools work in the same cut or groove, the rear tool cutting out a narrower groove than the front one. The machine is designed to handle ingots up to 24 inches diameter and the range of spindle speeds is 1.6 to 18 revolutions per minute. Its gross weight is about 110,000 pounds exclusive of motor drive. The builders recommended a 90 horse power motor of the

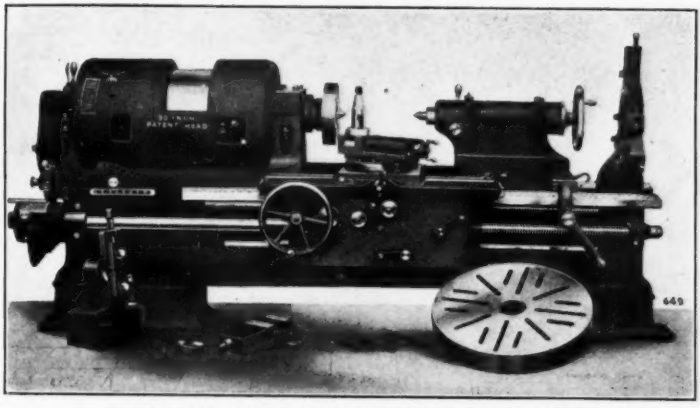


FIG. 5. LODGE & SHIPLEY 30-INCH PATENT HEAD LATHE.

direct-current type with a speed variation of two to one. The function of this machine is made clear by the illustration, and its massive design is indicative of the service to which it is subjected.

The above illustrations were included principally to emphasize the importance of the initial definition of work to be handled as a factor in the design of machine tools for maximum production. Almost any work can be economically performed upon full automatic

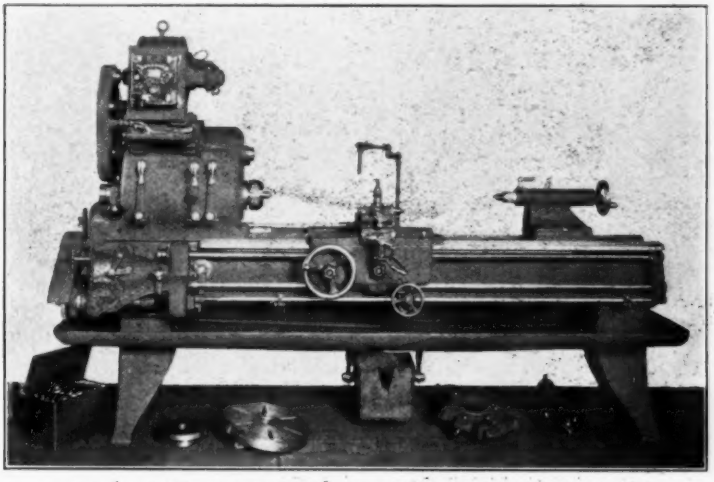


FIG. 6. PRATT & WHITNEY 16-INCH MOTOR-DRIVEN ENGINE LATHE.

machines provided the same operations can be repeated a great number of times. Modern practice, however, has made it possible to curtail greatly the machine time for many parts that are made in limited numbers only.

There will always be a field of usefulness for machines of all classes designed for a wide range of work, because in many shops little opportunity for duplication exists and for the performance of work upon large parts highly specialized machines can rarely be kept sufficiently busy to justify the large investment charges. The

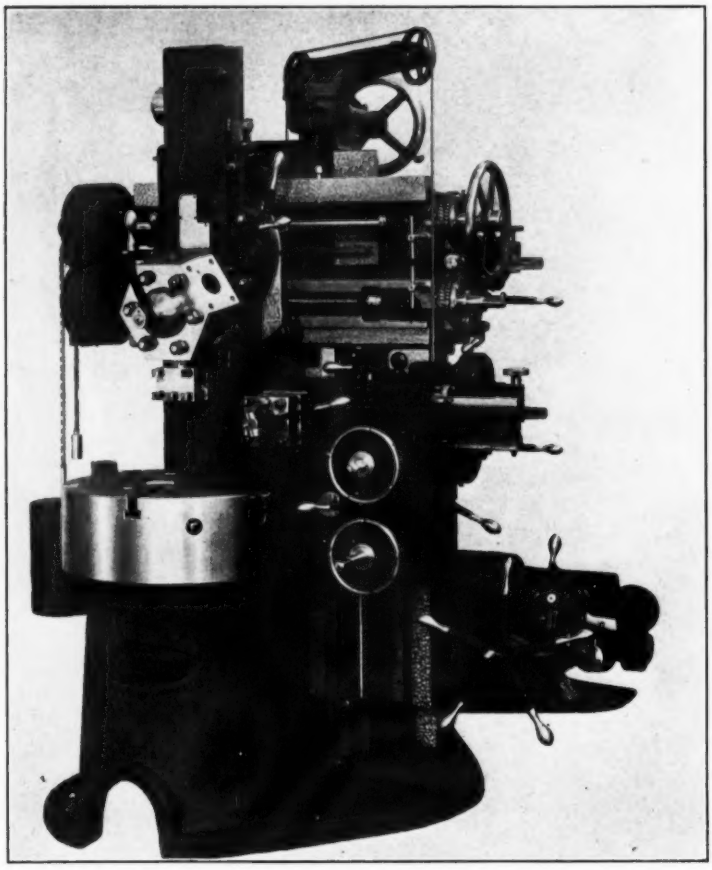


FIG. 7. BULLARD 24-INCH VERTICAL TURRET LATHE.

machines illustrated by Figures 5 to 20 inclusive serve to exemplify the advance that has been made in machines of standard types without curtailing the range of work that can be accommodated.

The Lodge & Shipley belt-driven lathe (Figure 5, page 731) was selected for the purpose of exemplifying the type adapted to the broadest conditions, as opposed to the single-purpose lathe. The replacement of the cone-pulley drive by the change-gear transmission which has been so generally effected in machines of all types is well illustrated by the patent head which readily transmits power for maximum demands and in conjunction with the countershaft a consistent number of speeds can be secured. In addition, one of the most desirable features of this type of transmission is that it necessitates a minimum effort upon the part of the operator when changing speeds, and it thus represents a great advance over the step-cone pulley drive.

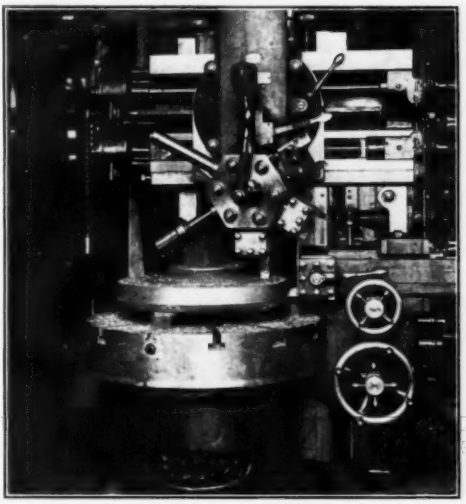


FIG. 8. BULLARD VERTICAL TURRET LATHE SET UP FOR A JOB.

This problem of facility of operation is most difficult to solve for machines suited to a wide range of work, although very great progress has been made during recent years. It is an especially important matter for large machines as the unit charge for setting up and taking down work is proportionally large on account of the high machine-hour rate. It is in this regard that the standardization of tee slots, clamping bolts, blocking, and special means for handling heavy parts plays such an important function.

The 16-inch motor-driven engine lathe built by the Pratt & Whitney Company (Figure 6) is a good example of the latest practice in small lathe construction.

An excellent illustration of machines designed for a wide range of duty is the Bullard vertical turret lathe described by the Bullard Machine Tool Company as "A multi-purpose machine tool of almost

universal adaptability for pieces coming within its range." The 24-inch machine is shown in Figure 7, and the setting of the tools for a given job by Figure 8. Although this vertical turret lathe accommodates a very great variety of work, and a considerable range in sizes, efficiency has by no means been sacrificed, but rather has the opposite result been brought about through a design that permits, in some cases, of the simultaneous operation of four tools on a single piece and that minimizes idle time through the facility afforded when making adjustments. The single-column box construction with broad base, well ribbed throughout, is suited to resist strains and eliminate the chatter which is so destructive to the cutting tool. The convenience of the gear change drive is taken advantage of to the full.

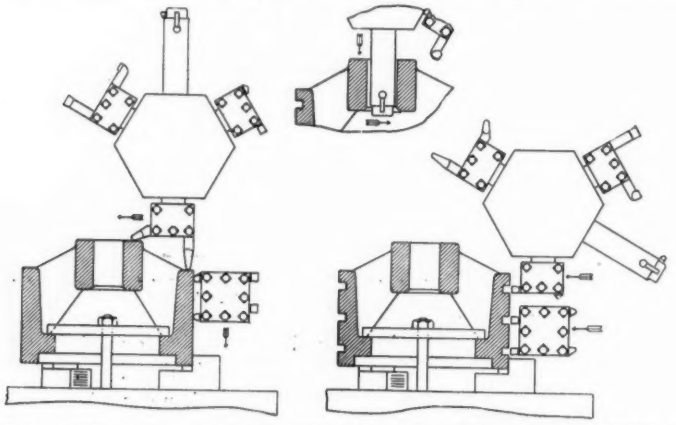


FIG. 9. OPERATIONS PERFORMED ON CAST-IRON PISTON HEAD WHEN MACHINED ON BULLARD VERTICAL TURRET LATHE.

Fifteen table speeds arranged in geometrical progression can be secured without stopping the driving pulley and a brake is used to check idle revolutions of the table. The control of the machine has been centralized to a very great extent and interlocking devices are used to obviate break-downs. The independent universal movement of both vertical and side heads permits of the use of single point rather than formed tools, and in the words of the maker "a four-inch gear blank and a fly-wheel requiring the full capacity of the machine may be completed with equal facility with the same tool equipment." The feed gears are independent for each head and micrometer dials and observation stops add to the completeness of the design.

In many respects this machine illustrates well the trend of machine-tool practice, and on this account it has been described in some

detail. Figure 9 shows the operations performed when roughing a cast-iron piston head (18-inch diameter, 10-inch space) to within 1/16 inch of finished size. The time for this job is 45 minutes. The finishing cut is taken after the head is forced upon the rod.

Aside from the defining of work to be done and the manner in which it should be performed, modern practice has been concerned chiefly with the severe duty exacted by modern cutting tools. It was soon found that their maximum performance taxed the materials that were formerly used for machine-tool construction beyond the point where satisfactory operation is possible. The machine-tool builder profited considerably in regard to this matter through the experience of the automobile makers, for the heavy moral responsibility which rests upon the latter made it imperative that they should satisfactorily meet the duty imposed upon the materials of construction—that is, lightness without sacrificing toughness and strength. Gears and shafts made of nickel-, vanadium-, chrome- and other alloy-steels are now used in both these businesses, so that it is absolutely necessary that the designer be thoroughly conversant with their known properties, and in touch with advancement work that is going rapidly forward. Much of interest and value concerning this subject will be found in the paper by John Mathew published in the *Journal of the Franklin Institute*, May 1909.

Almost any of the modern machine tools could be used to illustrate the changes that have been necessary in the details of construction in order that they may withstand present day demands. The new Cincinnati Bickford high-speed plain radial drill press illustrates interestingly the recent progress made in high-speed drilling. The 72-inch machine weighs approximately 21,000 pounds and is equipped with a 20 horse power type S, Westinghouse constant-speed motor. The transmission is composed of nickel-steel gearing, and twenty different spindle speeds arranged in geometrical progression are secured by means of a speed box, operated by a single lever and four changes on the head. A lever in reach of the operator actuates the only friction clutch in the transmission which is used to start, stop and reverse the spindle. The feed box and certain other features distinctive of former Bickford radials are incorporated in the machine, although they have been redesigned to suit the extraordinary requirements. Eight feeds are provided, arranged in a geometrical progression from .006 inch to .048 inch per revolution of the spindle. The sizes of shafts and bearings, features of lubrication, and other details have been worked out with much care, and especially the structure of the bed, column and arm, so as to secure great rigidity during maximum work.

I recently observed certain tests on this machine and the results are worth recording. A number of 3-inch holes were drilled through a block of cast iron 4 inches thick with a Celfor drill operating at 187-feet cutting speed in about 35 seconds, or at a feed of 6¾ inches per minute. The same radial drill press operated a ½-inch Celfor drill at 70-feet cutting speed and a feed of 27 inches per minute, the cast-iron blocks being drilled through in less than 9 seconds. Of course the cutting speed during the first test was abnormally high, although the drill was in good condition after the work was done. In the latter instance the drill was apparently perfect after drilling a very large number of holes. Over 20 horse power was required to drill the 3-inch hole at the rate mentioned, exemplifying a condition of operation that would have been scarcely conceivable a few years ago. The extensive experiments that the designer, Mr. H. M. Norris, has conducted regarding the drilling of metals formed the basis for the design of this radial, so that the problem was one of satisfactorily meeting known requirements.

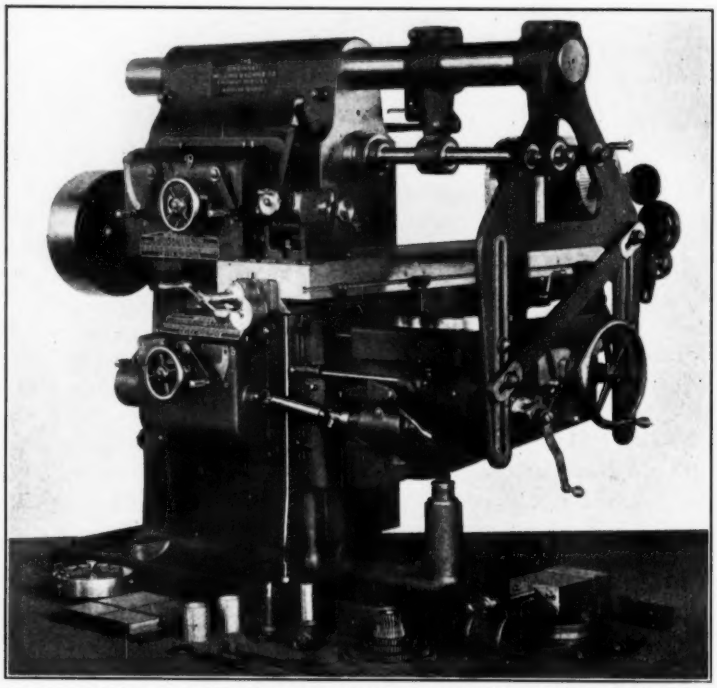


FIG. 10. NO. 5 UNIVERSAL HIGH-POWER MILLER. CINCINNATI MILLING-MACHINE CO.

Tests recently made by Mr. Geo. E. Hallenbeck indicate that the most rapid drilling can be done by using comparatively high speed and moderate feeds, as it is possible to carry a heavier feed at a high speed than at a medium speed. Mr. Hallenbeck's tests were made on a modern Baker Brothers' drill press and showed results that checked with the test on the ½-inch drill described above.

Machine-shop practice has made noteworthy progress in regard to milling work. Figures 10 and 11 show the No. 5 universal high-power miller and, in part, the No. 4 vertical high-power miller built by the Cincinnati Milling Machine Co.

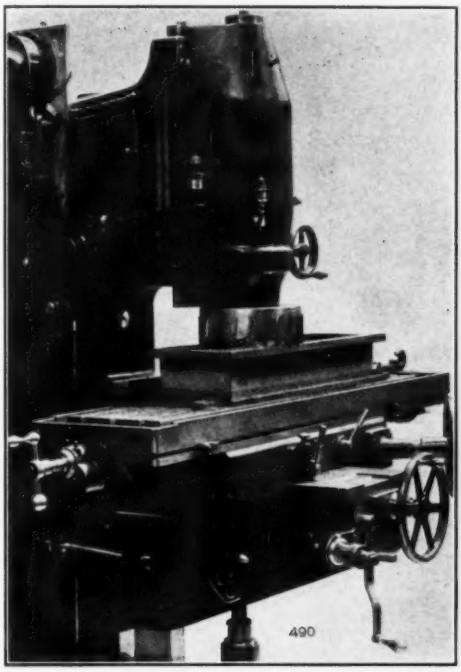


FIG. 11. NO. 4 VERTICAL HIGH-POWER MILLER, CINCINNATI MILLING MACHINE CO.

This concern has established a fixed duty at the cutter as the basis of design for each of their milling machines. Extensive cutting tests were conducted for the purpose of determining these standards, which are based upon the milling of machinery-steel blocks 5 inches square and 18 inches long, analyzing 16 points carbon and 51 points manganese; tensile strength 55,000 pounds per square inch, elongation 50 per cent. The No. 4 miller when equipped with a standard spiral milling cutter with nicked teeth will take a cut across one of these blocks 5 inches wide and ⅛ inch deep, at a table speed of 9¼ inches per minute, which is at a rate of 6.1 cubic inches of metal removed per minute. This practice, which is also being followed by certain other machine-tool builders, is rapidly tending to place the sale of equipment solely upon a basis of the quantity and quality of work that it can produce, rather than upon a comparison of the structural

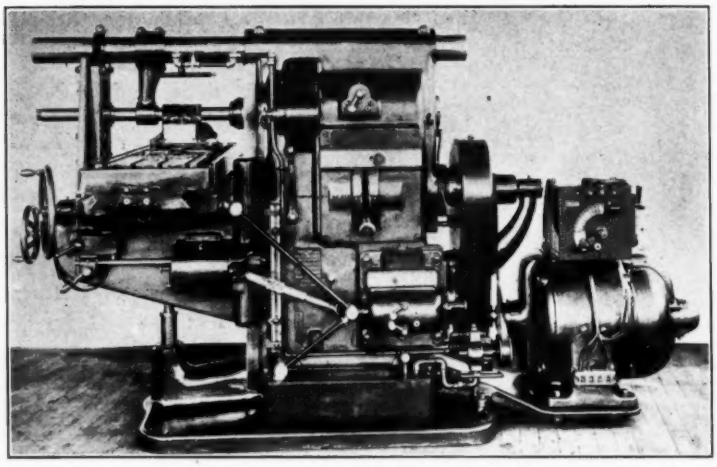


FIG. 12. NO. 5 HEAVY PLAIN MILLING MACHINE. BROWN & SHARPE MFG. CO.

features, which is often quite misleading to those not familiar with the principles of design.

Interchangeability of parts between horizontal and vertical types of milling machines and for different systems of drive and feed is now recognized as important to the purchaser, and the Cincinnati Milling Machine Company have satisfied this condition very efficiently.

The possibilities of modern milling-machine design were nicely shown by the operation of a Brown & Sharpe No. 5 heavy plain milling machine (Figure 12) exhibited at the Master Mechanics' Convention during June of this year. The floor upon which the machine was set up without bolting, settled 1¼ inches after being loaded. In one instance high-speed cutters, 3¾ inches diameter with spiral nicked teeth, milling carbon steel (65,000 tensile strength and about 40 points carbon) operated satisfactorily at a cutting speed of 60 feet per minute, width of work 6 inches, depth of cut 3/16 inch, and table feed 16 inches per minute. A number of delicate tests were made during the performance of this work to demonstrate the rigidity of the machine. The same gang of cutters made over one hundred cuts across the test piece under the conditions enumerated and their life was by no means reached, their capacity being probably in the neighborhood of 200 cuts.

The feeds and spindle speeds provided for in this machine are arranged in geometrical progression and are independent. The feeds are all given in inches per minute so that after the cutter has been brought up to the proper peripheral speed the feed can be readily

adjusted to the point best suited to the nature of the work and type of cutter used. This practice in itself represents quite an advance in milling-machine design, and is followed by the builders of not only the types of machines illustrated but those for other purposes.

Figure 13 shows the Brown & Sharpe No. 6 automatic gear-cutting machine which is referred to in this part of the article on account of its interest from a standpoint of milling operations. It has been gradually modified since it was put upon the market years ago, to meet the advances made in high-speed cutters, and in this respect is a good example of the evolution through which machine tools must go in order to keep abreast of the times. An interesting piece of work was recently performed on this gear cutter in the shop of the Brown & Sharpe Mfg. Co. A cast-steel gear, 119 teeth, 2-inch pitch, 5-inch face, was finished from the solid without previously roughing with a

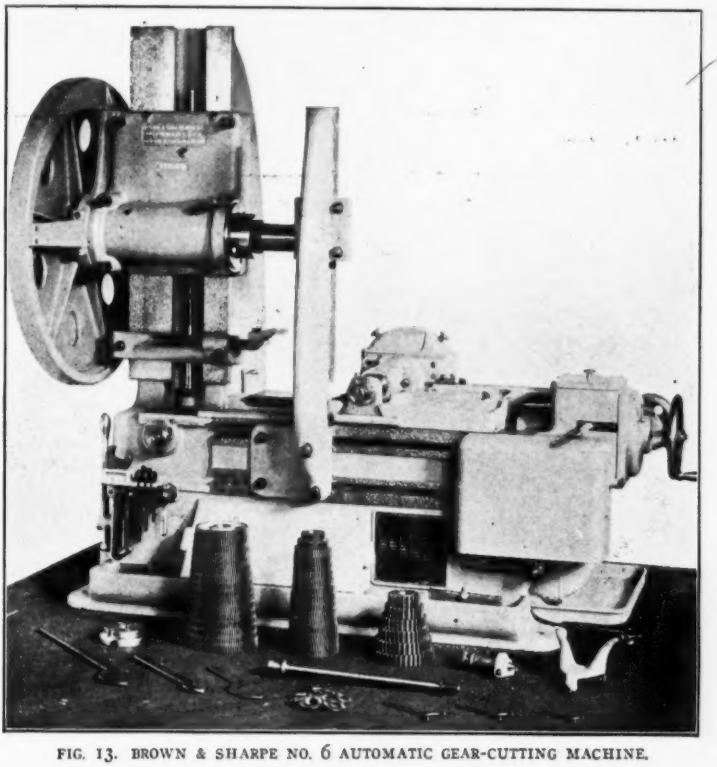


FIG. 13. BROWN & SHARPE NO. 6 AUTOMATIC GEAR-CUTTING MACHINE.

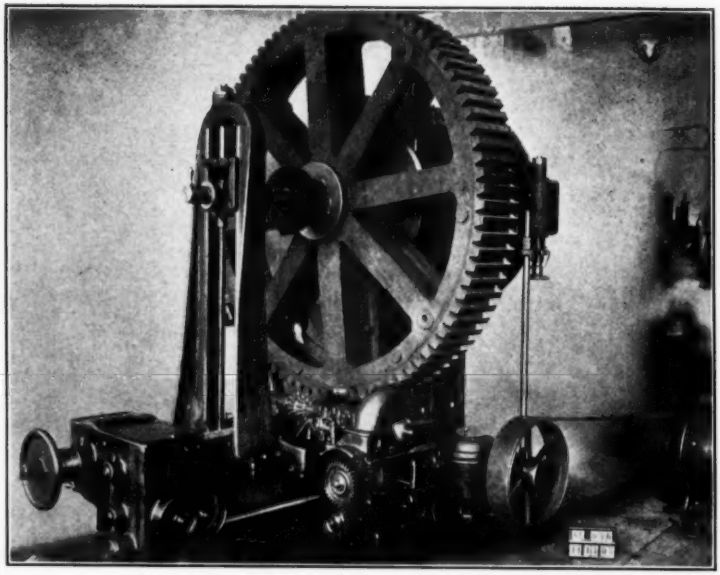


FIG. 14. GOULD & EBERHARDT 84 BY 16 IN. NEW TYPE AUTOMATIC GEAR CUTTER.

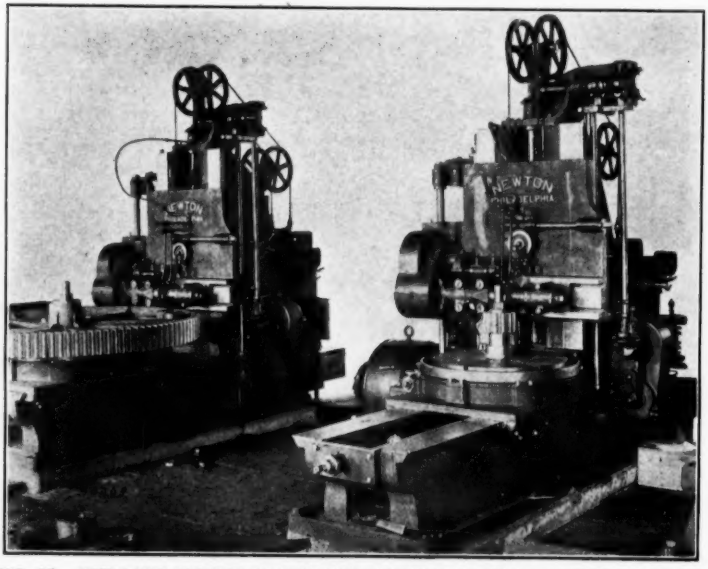


FIG. 15. NEW RAPID-PRODUCTION SPUR-GEAR CUTTING MACHINE. NEWTON MACHINE TOOL WORKS.

6½-inch diameter high-speed steel cutter, the spindle revolutions being 38 per minute and the feed 1 15/16 inches per minute. The cutting time per tooth was 4 minutes and the time for the entire gear 8 hours and 13 minutes. In no case did the teeth vary more than 0.001 inch, a degree of accuracy well within the requirements of commercial gear cutting.

Figure 14 illustrates the 84-inch by 16-inch Gould & Eberhardt new type automatic gear-cutter for blocking out a large cast-iron gear. This gear has 90 teeth, 3 inches circular pitch, 87.86 inches outside diameter and 12 inches face. The total time for blocking out and finishing was 7 hours and 35 minutes.

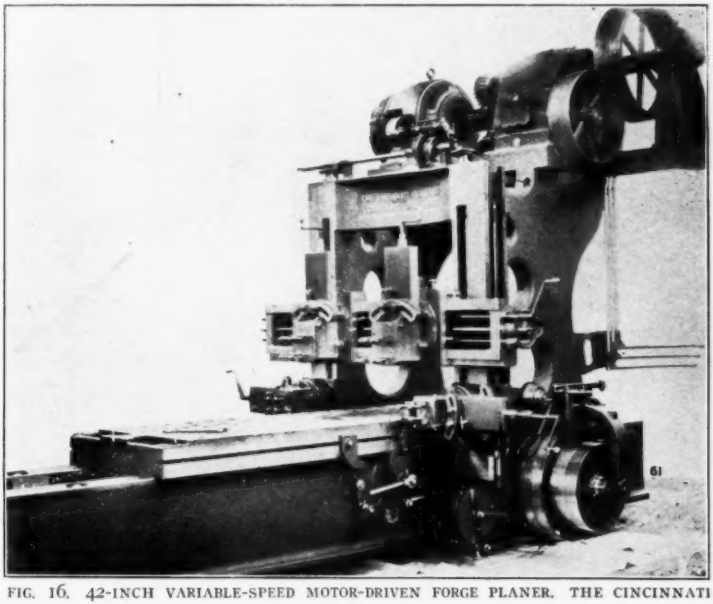


FIG. 16. 42-INCH VARIABLE-SPEED MOTOR-DRIVEN FORGE PLANER. THE CINCINNATI PLANER CO.

Figure 15 illustrates the new rapid production spur-gear cutting machine built by the Newton Machine Tool Works, and very interesting performances have been accomplished on this machine.

Brief reference should be made to machine tools of the reciprocating type, such as planers, shapers, and slotters, especially as these, considered as class, were not redesigned to meet new conditions as promptly as the types we have already considered. As no change in cutting speed is required on account of the dimensions of the work, it was some time before its need in order to meet the requirements of

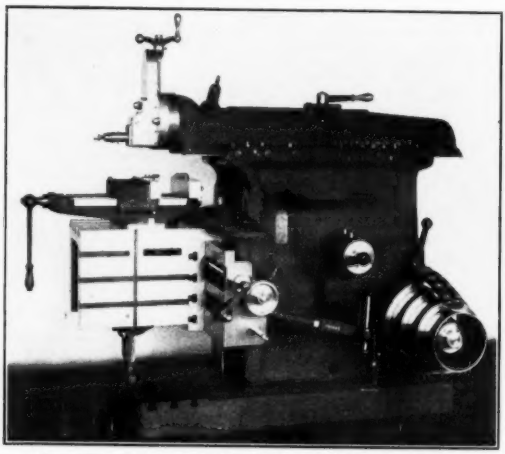


FIG. 17. GOULD & EBERHARDT 24-INCH SHAPER, HIGH-DUTY.

different materials and different kinds of cuts was properly appreciated. Much importance has been attached to the speed at which the work is returned, whereas a simple calculation will at once show that a variable cutting speed is a far more important matter. For example, with a cutting speed of 20 feet per minute and a return speed of 80 feet per minute, the cutting feet per hour would be 960. If the speed of the return is doubled (160 feet per minute) the cutting feet per hour would be 1,066, or a gain of 11 per cent. On the other hand, if the cutting speed is doubled (40 feet per minute) and the return kept at 80 feet per minute, the cutting feet per hour would be 1,600, or a gain of 66 2/3 per cent.

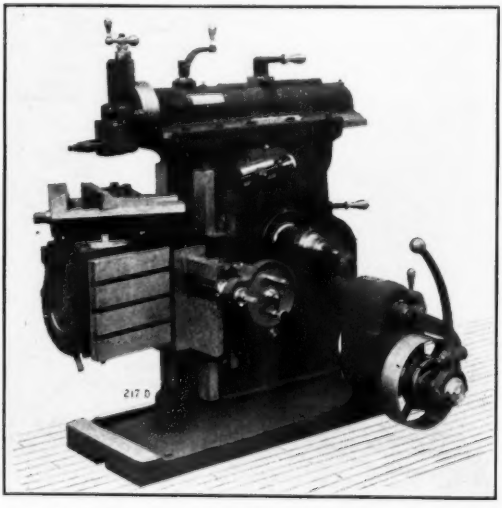


FIG. 18. GEARED SHAPER, 16-INCH, WITH FRICTION CONTROL FOUR-SPEED DRIVE. AMERICAN TOOL WORKS CO.

This fact is fully recognized in the design of the machine illustrated in Figure 16 which is the 42-inch variable-speed motor-driven forge planer built by the Cincinnati Planer Co. The motor is rated

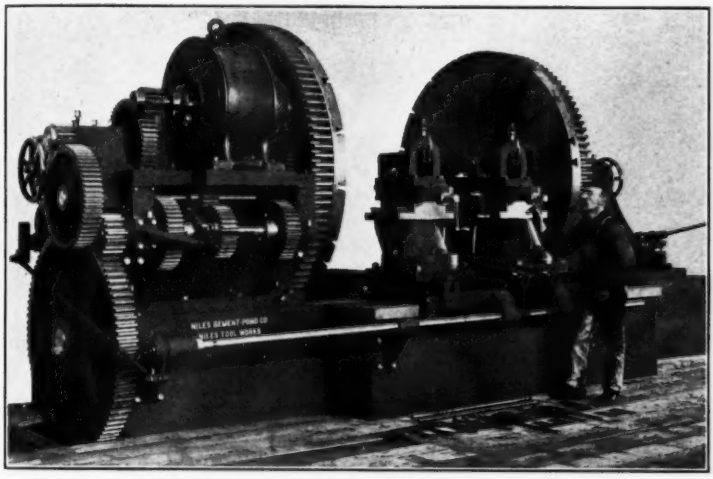


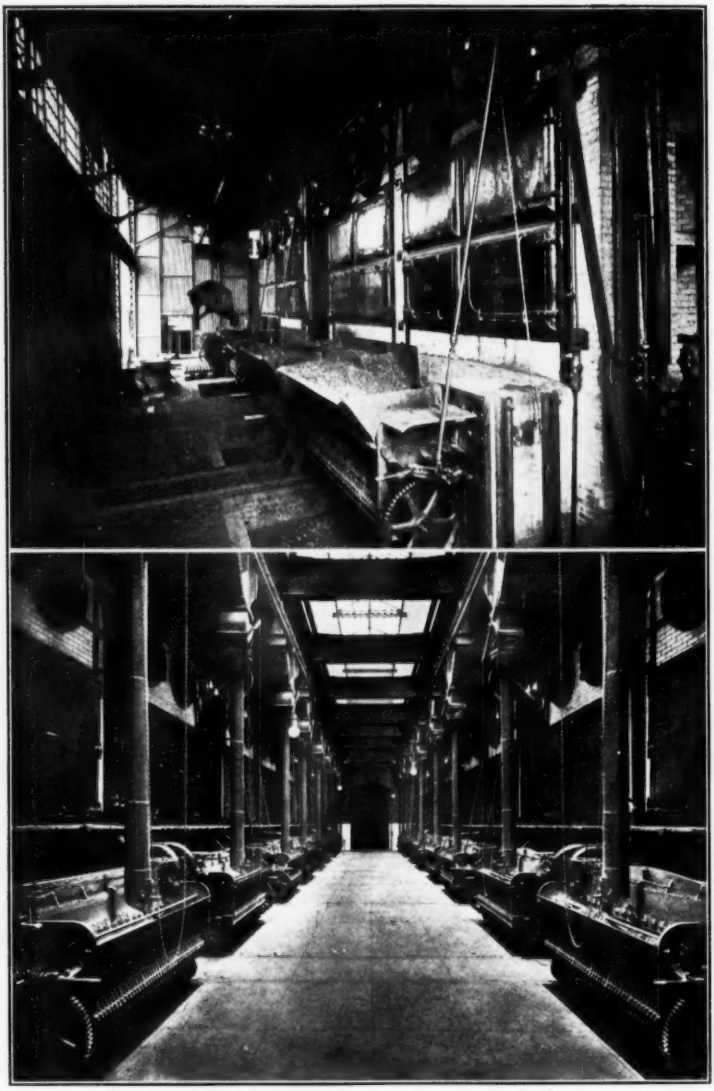
FIG. 20. NILES 90-INCH DRIVING-WHEEL LATHE.

at 20 horse power and is the compound-wound direct-current type. The return speed is fixed at 80 feet per minute and cutting speeds of 15, 20, 25, 30, 35, 40 feet per minute can be had by means of the positive variable-speed drive mounted on the housings. In the main particulars this illustration is self explanatory.

Figures 18 and 19 illustrate respectively the shapers built by Gould & Eberhardt and the American Tool Works Company. Each of these machines possess features that adapts it to the requirements of high-speed work.

Figure 20 is included as an example of the modern equipment which has been perfected to meet the severe service exacted in modern railroad shops.

A full realization of the advance that has been made in machine-tool practice during recent years can be had only by making a minute study of the subject. Many seemingly unimportant details have contributed largely to the success of individual types of machines, and I regret that it has been necessary in this article to select, as illustrations, only a few of the many admirable machines on the market.



BABCOCK & WILCOX STOKER INSTALLATIONS.

Above, the Cleveland Hardware Co.; below, the Fisk St. station of the Commonwealth Edison Co., Chicago.

SMOKE PREVENTION OR SMOKE CONSUMPTION.

By Harold V. Coes.

In two preceding articles Mr. Coes outlined the causes of smoke, reviewed the methods employed to prevent or diminish smoke in hand-fired plants, and described the leading types of automatic stokers with a frank summary of the advantages and disadvantages of each. This concluding paper deals with the choice of apparatus for burning various grades of fuel, and with the prospects for applying automatic stokers to marine and locomotive service. —The Editors.

THE preceding discussion has presented the special features of excellence and some of the advantages and disadvantages of the several types of stokers. It has been the aim to demonstrate impartially the operation of the stokers and their means of smoke prevention, even though many installations of automatic stokers smoke very badly, frequently quite as badly as furnaces with poor hand-firing. If this is the case, it can generally be traced to one of these three sources:—

First—Improper design of both furnace and stoker.

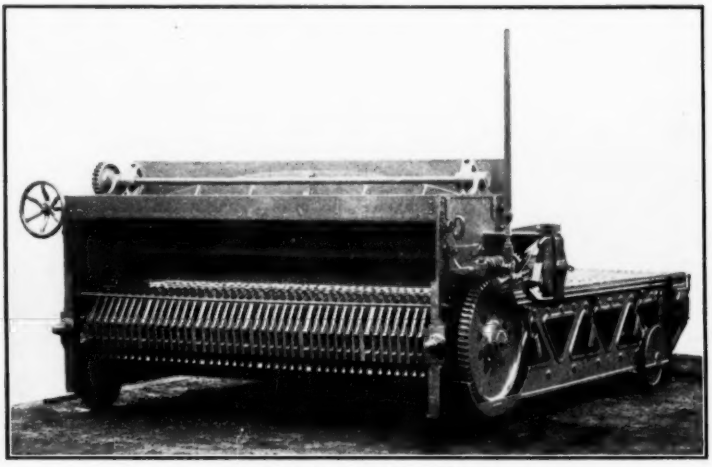
Second—Forcing beyond the capacity of the stoker, some stokers being unable to operate smokelessly much over 110 per cent of rating.

Third—Careless operation.

Some installations and conditions are better suited to one type and some to another, and it is of the utmost importance, in the selection of a stoker, that the owner should make sure that he has the type best suited to his conditions, and that the details of the particular apparatus be developed on sound mechanical lines based on mature judgment and experience.

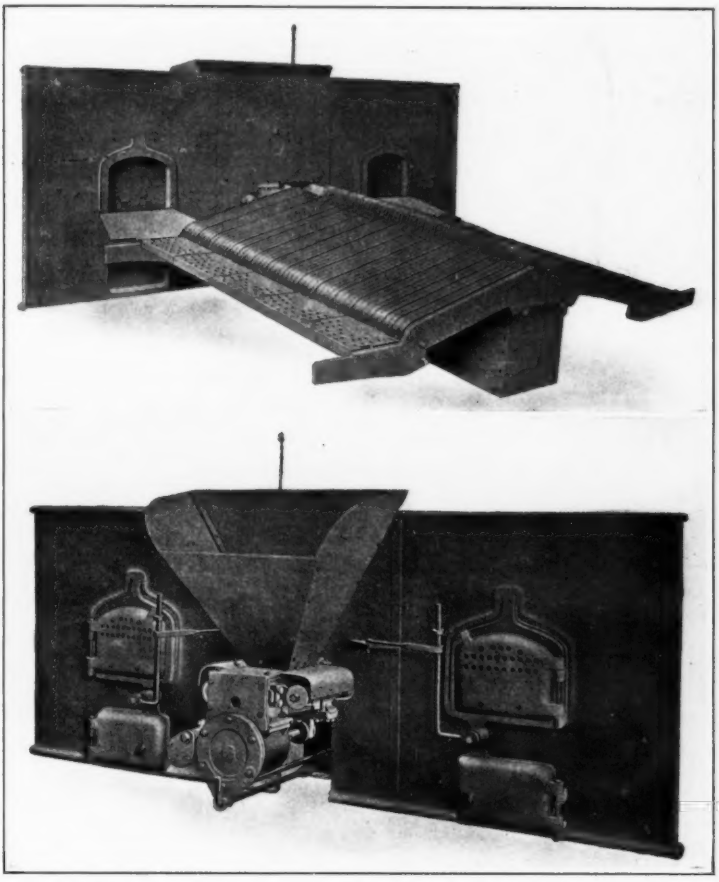
It is almost impossible to state just what particular kind of coal is best suited to a particular type of stoker. Broadly speaking, the American coals may be divided into two classes, viz., eastern bituminous, and western, or high-volatile bituminous, coal. Each class requires a different mode of boiler setting and furnace construction, especially the coking arches. The longer this arch is made, the longer is the travel of the hydrocarbons in contact with it, and consequently, the long time interval for perfect combustion to take place. With the lower-volatile eastern coals, this arch need not be over four feet in length in order to obtain complete combustion. As the per cent of volatile matter increases, the length of the arch increases

in almost direct ratio. It is also affected by the rate of combustion, so that with a knowledge of these two elements, a furnace setting can be designed which will be absolutely smokeless under all operating conditions. The prolongation of the arch just referred to may be accomplished in several ways and this usually constitutes the furnace or stoker setting. It should be distinguished from the stoker proper, inasmuch as it requires separate treatment and is distinct in its effect upon the completeness of combustion.



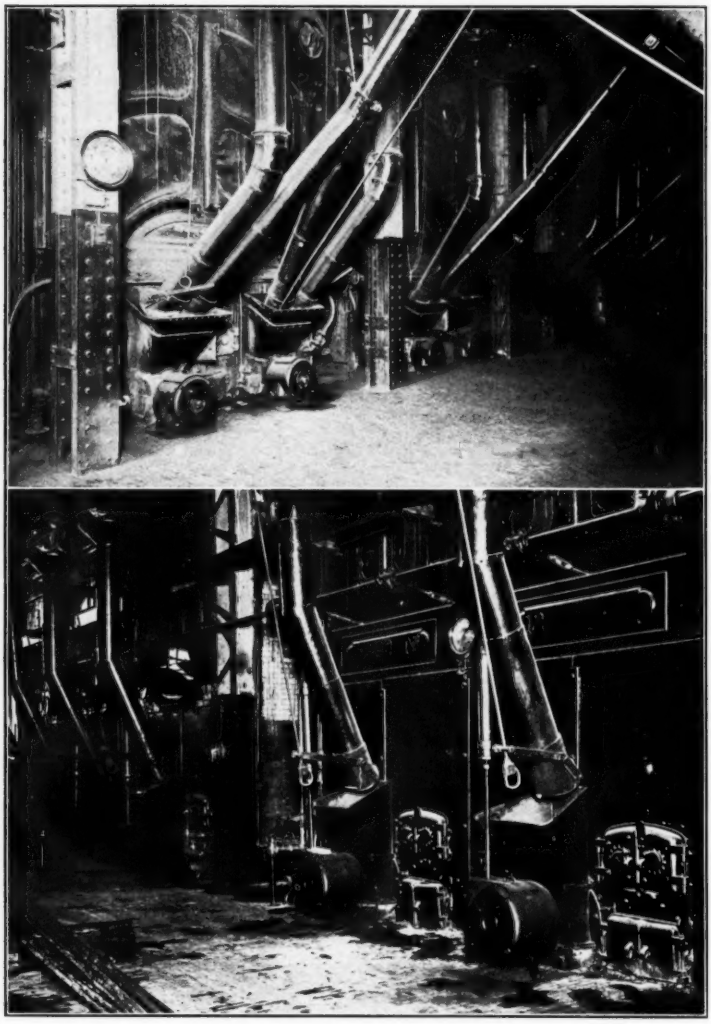
THE BABCOCK & WILCOX STOKER

In those types of boilers which are baffled horizontally, it is customary to hang to the lower row of tubes some form of encircling fire-brick tile. This tile extends backward to within a few feet of the rear water leg and forms a prolongation of the coking arch, 13 to 14 feet in length. (See page 797, in which type 3 is the best). In such boilers as do not ordinarily have tile on the lower row of tubes, we must provide equivalent arch effect, in order to prevent the flames from reaching the boiler tubes. This is accomplished by withdrawing the stoker from under the boiler and building around it a fire-brick extension fire box, usually termed a "Dutch oven," which, of necessity, has fire-brick roof and sides. The amount of this extension is determined by the minimum length of flame travel, *i. e.*, the flames must be extinguished or burned out by the time they reach the end of the arch or tile work. This amount of extension, as stated before, depends upon the locality and the kind of fuel consumed.



TWO VIEWS OF THE AMERICAN STOKER AS INSTALLED, SHOWING FRONT AND GRATES.

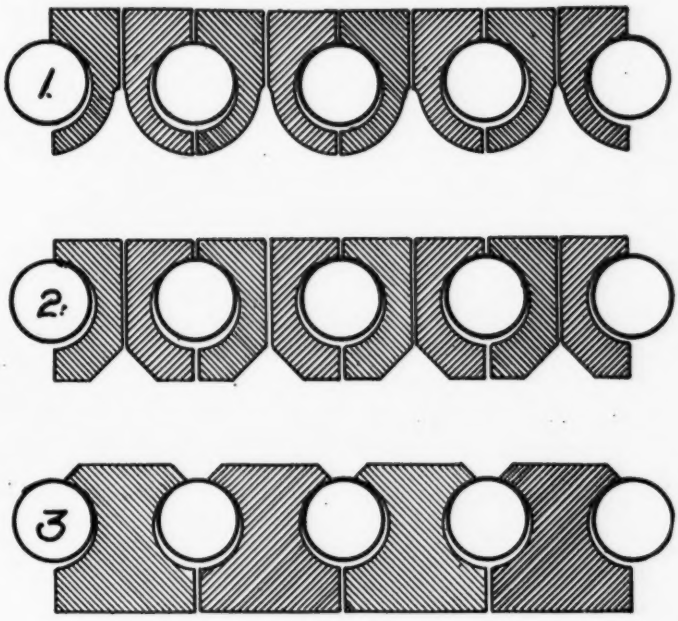
Many designs of furnaces and combustion chambers have been made with the idea of prolonging this time of travel by increasing the length. Projections from the furnace walls, wing walls, baffle piers in the combustion chamber, and arches across it, are some of the more common forms of producing tortuous passage for the gases. These devices, however, are not particularly effective in themselves, and unless there is a certain distance from the point of liberation of the volatile matter to the entrance of the tube spaces, incom-



INSTALLATIONS OF THE AMERICAN STOKER, IN THE POWER PLANT OF THE GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y.

In the new boiler plant of the turbine power house, shown above, there are 44 American stokers under 22 500-h.p. boilers. They are driven by shafting and eccentrics beneath the floor. The old power house, shown below, contains 12 American stokers firing 6 500-h.p. boilers. The drive here is by line shaft across the boiler fronts.

plete combustion must take place. These devices also act as an obstruction to the draft and the effect upon the draft over the fire is a serious thing to tamper with. It may be taken as almost axiomatic, regarding smokeless and economic combustion, that there is no effective substitute for actual size of combustion chamber; and furthermore, that with the elimination of smoke-forming matter and sufficient length of flame travel, perfectly smokeless combustion can be guaranteed.



THREE TYPES OF TILE ROOF FOR BOILER FURNACES.

The direct saving gained by stoker operation over hand-firing is due to two things—saving of fuel due to better combustion, higher boiler efficiencies and smokeless operation, and saving due to decreased labor attendance. This is not so apparent or so great in plants whose boiler capacity is about 1,000 to 2,000 horse power. The cost of boiler-room labor, averaged from plants containing 600 boilers in all, was 50 cents per ton of coal fired, ranging from 26 cents to 75 cents. The cost gradually decreases as the size of the plant increases, becoming, however, per ton of coal fired, nearly stationary when firing 1,200 tons per week. There is also a correction

to be made, depending upon the load factor, the cost of labor per ton being about 10 per cent less for a steady load than for a variable load.

In one of the large plants in New England, the cost of firing a ton of soft coal with automatic stokers, including the cost of the coal alongside the dock and the storage, ranged from $3.30 to $3.315, the cost of coal alongside the wharf being taken at $3.20 per ton.

Mechanical stokers save from 30 to 40 per cent of labor in very large plants (over 200 tons per week), 20 to 30 per cent in medium-size plants (50-150 tons per week), and no labor in small plants. Similarly they cut down the time of cleaning fires to about a tenth of that of hand firing, and in some types of stoker, the Taylor for instance, the labor and time for cleaning fires is reduced to a minimum.

The following figures of comparative costs of apparatus are taken from Professor Gebhardt's "Steam Power-Plant Engineering," supplemented by additional figures obtained from manufacturers. They represent the approximate cost of stokers suitable for a Babcock & Wilcox boiler of 350 horse power, rated capacity, with 45 square feet of grate surface, chimney 175 feet above grate, burning Illinois screenings. The cost of installation is not included. The figures for the various types discussed are:—

Chain-grate and appurtenances	$1,500
Jones underfeed stoker	1,400
Roney stoker	1,300
Murphy stoker and furnace	1,350
Hawley down-draft furnace	1,350
Taylor gravity underfeed stoker	2,000

Recommendations to the Purchaser.

1.—The purchaser should place the burden of responsibility upon the firm installing the apparatus, and no prospective purchaser should permit an installation unless he is thoroughly satisfied that the representative of the manufacturer has thoroughly studied all the conditions at the plant which may influence the success of the apparatus. When once installed, he should see that all claims for economy, maintenance, durability, flexibility, and smokeless combustion are fully substantiated.

2.—Specifications and plans for proposed plants should be submitted to some competent engineering authority for approval. Needless to say, such expert should not be connected with the selling interests of any stoker manufacturer and should have no commercial interests and affiliations apt to influence his judgment. The conditions necessary to insure successful operation of the stokers are well known to mechanical engineers making a specialty of combustion, and such an engineer, when once familiar with the existing conditions of the plant and its immediate needs, should be able to advise

the prospective purchaser intelligently, to his material advantage, as to the ultimate success of the proposed scheme, as well as regarding all details in connection with the installation.

3.—When it has been installed and the supervising engineer has shown that it is doing all that the manufacturers have guaranteed, it is the duty of the purchaser to see that the installation is operated according to the instructions of the manufacturers and to the best advantage. Many installations of merit have been condemned at the start by the operating staff of the purchaser, who were prejudiced or who knew nothing about the apparatus, and therefore, through no inherent defect, it has been condemned. There have been so many such instances that it is desirable to call the attention of the intending purchaser to this point, since it is just as important that the plant should be operated properly as it is that the apparatus be properly designed and installed.

Suggestions for Further Development.

The mechanical stoker has come to stay. As with a good many other adventures that have been made along untried and unexplored paths, mistakes have been made; but no industrial development of any character whatsoever has ever been made without mistakes creeping in. In case of the automatic stoker there have been mistakes due to faulty design, to misunderstanding or misapplication of the fundamental principles of combustion, and to poor installation. But, thanks to the persistency of purpose of the promoters and the inventors, we now have several good forms of mechanical stoker and are making headway.

The principal field which the stoker companies have developed and are developing is that occupied by the central station; though numerous installations have been made in small plants, in isolated plants, and in some manufacturing plants, the central-station work remains as yet the most important.

It is generally recognized at the present time that the art of burning coal and attaining perfect combustion is governed by just as accurate laws and scientific principles as those regulating the generation of steam. The old idea of a fire-brick box crammed full of coal and left to its own devices is antiquated. The modern idea is a furnace designed according to the principles of combustion, perfectly adapted to the kind of fuel to be consumed, to the character of the boiler, and to the nature of the service. It makes no difference what the service is, whether for steamship, railroad, central station, or isolated plant, as long as the designer has in view the requisites of the service and the conditions imposed.

It is with the chance for development in marine and railroad work that I wish to deal in conclusion. Practically nothing has been done along these lines, and yet the need is urgent and the returns would be well worth while to those entering this field boldly, confidently, and intelligently.

The stoke hole of many vessels, particularly in the tropical service, is a pocket edition of hell. Modern transportation has made so many demands as to speed that the problem of obtaining the maximum power for the minimum space, or what corresponds in central-station practice to the kilowatts per square-foot rating, is a difficult one indeed. When one sees a boiler in a central station working efficiently at 200 per cent of rating and burning 60 to 75 pounds of bituminous coal per square foot of grate surface per hour, as is being done with a recent stoker installation, he naturally wonders at the lack of development along the other lines just suggested. A stoker for such service must be compact, simple, durable, easily regulated, and able to do its work in rough seas without avalanching the fuel or interrupting the operation. This last condition practically throws the overfeed, movable grate-bar type of stoker out of the running. But the underfeed and gravity underfeed stokers are beautifully adapted to this class of service, for there are no moving grate-bars or loose fuel to be displaced.

The problem of handling the ash and coal for such an installation would be no mean one, but it offers plenty of opportunity for the exercise of the skill and ingenuity of the engineering staff of the conveyor manufacturers. That it can and will be solved is unquestionable. Modern service requires it, just as modern service requires the steam turbine in the hold of the Lusitania and vessels of her class.

The blowers and stoker can be run by small, compact, economical steam turbines, the exhaust steam from the turbines being returned to the feedwater heaters; and as this exhaust is free from oil, this is quite an item. Furthermore, these turbo-blower outfits can be installed in places where a reciprocating engine would be inaccessible, for no overhead room for the removing of cylinder heads and pistons has to be provided. Furthermore, the blowers do not have to be so large since they run at a higher speed. All these points are worthy of consideration where space is such a factor as it is aboard ship and on a locomotive.

The trouble due to the striking of firemen and their leaving at a foreign port is not nearly so serious an item, since a stoker installation would relieve the firemen of most of their present arduous duties. The saving in labor is another factor to be considered. The

increased capacity of such an installation, the ability to use economically a cheaper and poorer grade of fuel, are considerations well worthy the attention of naval architects and marine operators.

With a properly designed and equipped apparatus of the character outlined it would be possible to get more power per cubic foot of boiler space than can be obtained with any system of hand firing, and to do it economically.

Such an installation must be designed so that the boilers can be hand fired in case of any accident to the stoker mechanism, although, if this mechanism is properly designed and cared for, the danger of a breakdown here is just as remote as a breakdown to any other piece of machinery in the ship.

Conservatism will have to be combatted, experiments will have to be made; but the American spirit and Yankee ingenuity will tell in the end.

Similarly, we have the big field of railroad transportation. Modern traffic requirements have put the motive-power departments of most of the large railroads at their wits' ends to try and design locomotives capable of hauling the heavy trains at the speed that the public demands. The use of steel cars has added another weight to the ever increasing load. Electrification solves the problem for suburban and interurban work, but for long-distance hauls, steam is still the agent. To design a locomotive within the roadway limits, capable of generating a sufficient supply of steam for the demands made upon it, by a furnace within the limits of hand-firing, is a difficult problem indeed. Yet the motive-power officials are confronted with it every day.

There are limits to human ability and endurance and the modern locomotive fire-box taxes them to the utmost.

Stoker installations have been made on a number of locomotives with varied success, but the railroads either expected the stoker companies to adapt the stoker to the locomotive or the stoker companies expected the railroads to adapt the locomotive to the stoker, with failure as a result in either case. Co-operation is needed. The stoker designer must understand the railroad man's point of view; the locomotive designer must understand the stoker designer's theory and principles.

It again appears to me that the underfeed stoker is best adapted to this service, for the rounding of curves and nosing and rolling of the locomotive would seriously hamper the operation of a moving grate mechanism. If the underfeed stoker was used it would neces-

sitate a closed ash pit with forced draft. Many beneficial results would be obtained from a properly designed installation of this character:

1.—The forced-draft apparatus run in conjunction with the draft created by the exhaust from the cylinders could be balanced, doing away with leaky flues and strained tube sheets, for the fire-box temperature would be practically constant. Fire-doors would not have to be opened every few minutes with the attending inrush of cold air and decreased fire-box temperature; thus the stoker would strike at the very root of tube-sheet troubles.

2.—Cheaper and poorer grades of fuel could be used, for the fireman does not have to be considered here.

3.—Better combustion and more perfect operation could be counted on.

4.—Economic operation over wide load ranges can be expected.

5.—Sudden demands for overload capacity can be quickly answered.

6.—Sudden demand from a banked condition is promptly responded to on account of the thick fuel bed carried.

7.—Fires can be cleaned while running without interfering with the operation or capacity.

A stoker for such an installation must be designed to meet all the above requirements. It must be free from complication and repair parts easily replaceable. It must have no moving parts in the fire. It must be capable of being hand-fired, should any accident happen to the actuating mechanism. The fuel bed must be maintained in an even condition in all positions and movements of the locomotive. The hoppers must be capacious and easily and readily filled by the fireman. In other words, the demands made upon a stoker designed for central-station service are vastly different from those made upon a stoker adapted to locomotive operation. Yet the fundamental principles underlying combustion are the same. It is simply a question of adapting these to the conditions of the service required.

Here again the field is big, the opportunities many. Let us hope that the next few years will see the automatic stoker take the place in industrial development that belongs to it; that better and more perfect combustion may be realized; and that increased capacity from the present limited installations may be obtained.

THE ALASKA-YUKON-PACIFIC EXPOSITION—THE FAIR THAT WAS READY

By A. J. Quigley.

AT Seattle, on June 1, at 8:30 A. M., the gates of the Alaska-Yukon-Pacific Exposition were thrown open to the world, and to the amazement of the thousands who came the Fair was complete and finished. Only the pessimist was disappointed, for he found clean asphalt pavements, verdant green lawns, beautiful gardens in luxuriant array, and majestic buildings sparkling in fresh paint and bedecked with myriad-colored bunting. What matter if an army of men did work night and day at the end of May; what if acres of sod were laid in one night; what if buildings were shorn of scaffolding and suddenly completed while trees and flowers sprang up about them as by magic? The world could only wonder at the result; but those who worked knew the keener joy of a success attained, of a promise fulfilled, of a Fair ready on the date that was originally set. And so all was ready and waiting for the formal opening at 12 noon when President Taft at the White House officially welcomed into being the Fair that is already acknowledged as the most beautiful, and which gives every promise of being the most successful ever held.

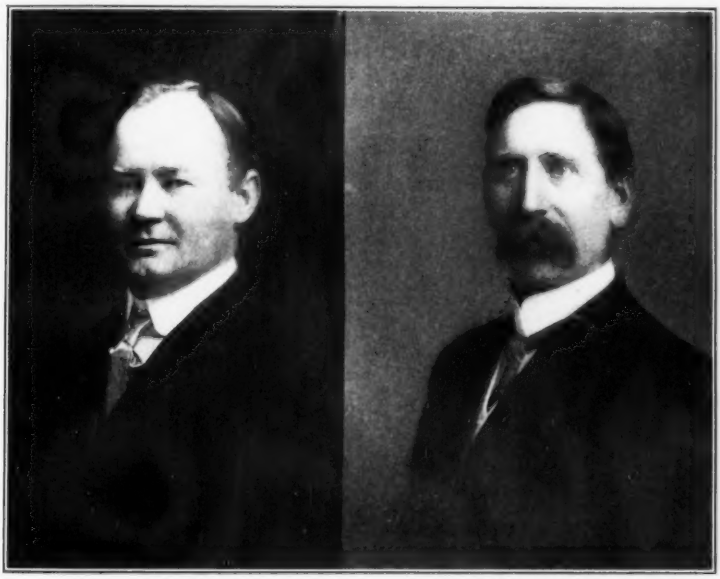
Historically the Exposition is a triumph to the Hon. Wm. H. Seward, that wise statesman of Civil War fame who yet maintained to the end of his days that the most important act of his administration was the purchase of Alaska from Russia. The price paid was $7,200,000 and the deal was put through only in the face of the most violent opposition. The consensus of opinion seemed to be that Alaska was a bad bargain at any price—a white elephant that had been foisted onto the United States under cover of a natural desire to reciprocate to Russia for her kindness during the Civil War. And yet after the lapse of a generation the State of New York has seen fit to erect at Seattle as its State Building a beautiful structure which "is a replica of the home of William H. Seward, whose far-sighted statesmanship gave Alaska to the United States." A generation ago the potential greatness of Alaska was little dreamed of. A decade ago, with the discovery of gold, came a tardy realization by a few people

of some of the possibilities of Alaska. Even today, however, the rank and file of the United States look upon Alaska as a land of snow, ice, and gold, and so we have the justification for a Fair in the heart of the Pacific Northwest whose purpose is "to exploit and make known to the world the possibilities and resources of the Alaskan, Yukon, and Pacific countries and the great Pacific Northwest." Always before Alaska has been pictured as a land of cold and gold. The comparatively few who have learned better are using this Exposition to teach the world of the hundred of thousands of acres of excellent farming land, of the great forests of timber wealth, of the coal and mineral deposits, and of the fishing banks. The key-note of the situation was sounded by Hon. J. J. Hill in his address on Opening Day, when he said that this Exposition can justly lay claim to a larger purpose than any other previous like enterprise, because heretofore the inspiration has come from a looking backward to some great event of history, whereas this Exposition leaves the past behind and strives to look forward into the golden future that lies before these undeveloped countries.

BUILDING THE EXPOSITION.—Where today stands a beautiful Exposition complete in every detail there stood less than three years ago a dense forest of high pines and undergrowth, in such virgin state that the preliminary surveys were made only after the axmen had cut the way through. The site selected was a tract of ground lying between Lake Washington and Lake Union, with a shore line on each body of water and consisting of some 250 acres. This land is the property of the University of Washington and is located about 6 miles from the center of the city. In every way the selection of this site was a wise move. First of all, because the University is to receive after the Fair is over all the buildings that she can utilize, and hence many permanent structures have been erected, thereby preventing the usual great economic waste. Again the natural setting is superb, for the high rolling ground gives everywhere beautiful views of the lakes and mountains. Finally, the climatic conditions are such as to make possbile a fairy land of flowers, shrubs, and trees, the like of which has never before been seen.

Unlike other fairs this Exposition did not call for Government backing. Instead, the people of Seattle financed the enterprise by general subscription to the extent of $1,000,000, the State of Washington furnished $2,000,000 more, and other States have furnished nearly another $1,000,000. The Government appropriated $600,000, every cent of which has been used for its own buildings and exhibits.

These amounts, together with the investment represented by individual concessioners and exhibitors, have been used to prepare the grounds and erect some 150 buildings. Taken as a whole the proposition stands as a $10,000,000 enterprise and the money has been carefully spent.



J. E. CHILBY,
President of the company.

GODFREY CHEALANDER,
Father of the exposition.

An exposition is of necessity a veritable complete city with a fully equipped system of utilities, such as water, gas, and light. The civil engineer has played an important part in the construction period, as under his supervision there have been constructed 8 miles of sewer mains, 7 miles each of large and small water mains, 10 miles of asphalt pavement, and many miles of paths and tracks, and 500,000 cubic yards of earth have been moved.

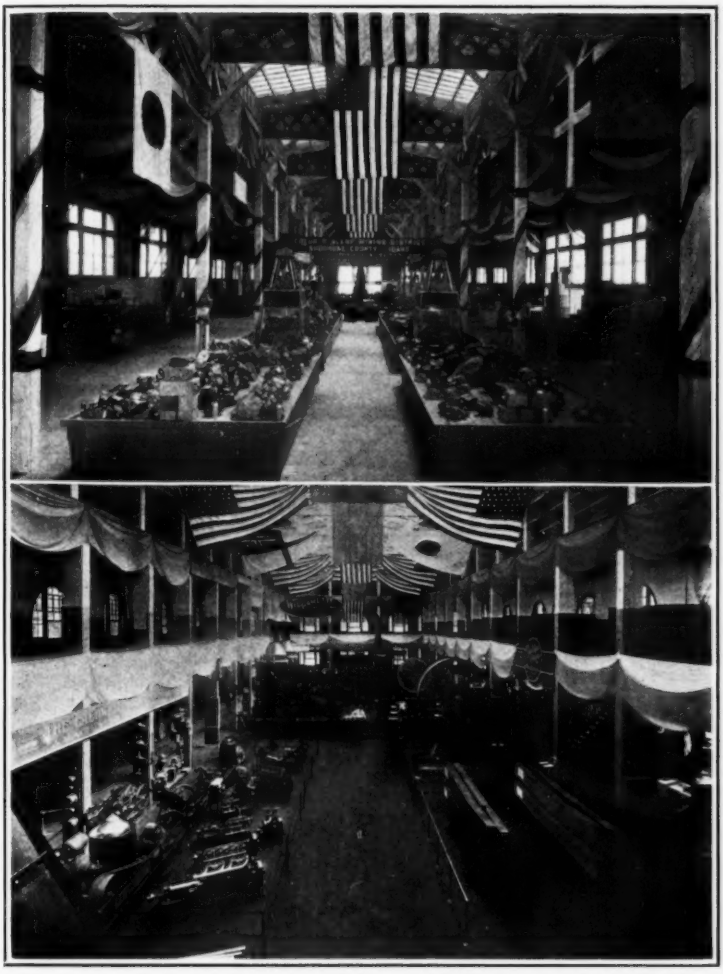
It is possible to speak but briefly of the grounds and buildings. The Court of Honor contains a geyser basin and a six-fall cascade, all within a sunken garden. About these are grouped the main exhibit structures, viz., Manufactures, Oriental, Hawaiian, Main Government, Alaskan, European, and Agricultural Buildings. To the rear of these in roughly concentric circles are the other structures, the more important of which are Forestry, Machinery Hall, Philippine, Fisheries, Auditorium, Fine Arts, and Mines. Complete and attractive buildings

SOME OF THE EXPOSITION BUILDINGS WHICH WILL BECOME THE PROPERTY OF THE UNIVERSITY OF WASHINGTON.

Good Roads.
Auditorium.

Forestry.
Washington State.

Fine Arts.
Machinery Hall.



INTERIORS OF MINES BUILDING (ABOVE) AND MACHINERY HALL (BELOW).

have been erected for Japan, China, and Canada, while State buildings have been erected by Oregon, Washington, Idaho, Utah, California, and New York. Various county and special exhibit buildings and a long list of amusement attractions—called here "The Pay Streak"—complete the physical equipment. Throughout, quality rather than magnitude of construction has been aimed at and this idea shows itself

THE EXPOSITION AT NIGHT, FROM CAPITOL HILL, TWO MILES AWAY.

in the grouping and treatment of buildings which are set close together and treated as a combined unit—a pleasing departure in exposition building. The main axis is the Cascade Court, at the upper end of which is the Main Government Building with Mt. Rainier, that grand sentinel of the coast, at the other end, towering up into the sky in full view.

ENGINEERING FEATURES.—No particular novel feats stand out from the mass of construction detail, although in all departments difficulties have naturally been met and overcome.

Electrically the aim has been to produce beauty and harmony rather than the unusual. The decorative lighting of all buildings and grounds has required a total of 250,000 8-candle-power frosted lamps. These have been used in outline, soffet, and indirect lighting on 18-inch spacing and against the ivory white of the buildings give a peculiarly soft and pleasing effect. For the grounds a special type of staff electrolier was designed and over 200 used. Each unit contains 39

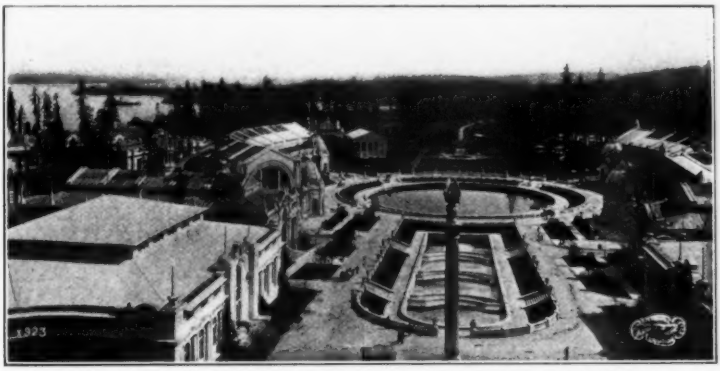
THE ALASKA-YUKON-PACIFIC EXPOSITION. COMPLETED ON THE OPPOSITE PAGE.

Arctic Brotherhood | Fire Hall | Forestry | Oregon
California | Washington State | Hawaii

LOOKING UP CASCADE COURT, AS IT IS ILLUMINATED AT NIGHT.

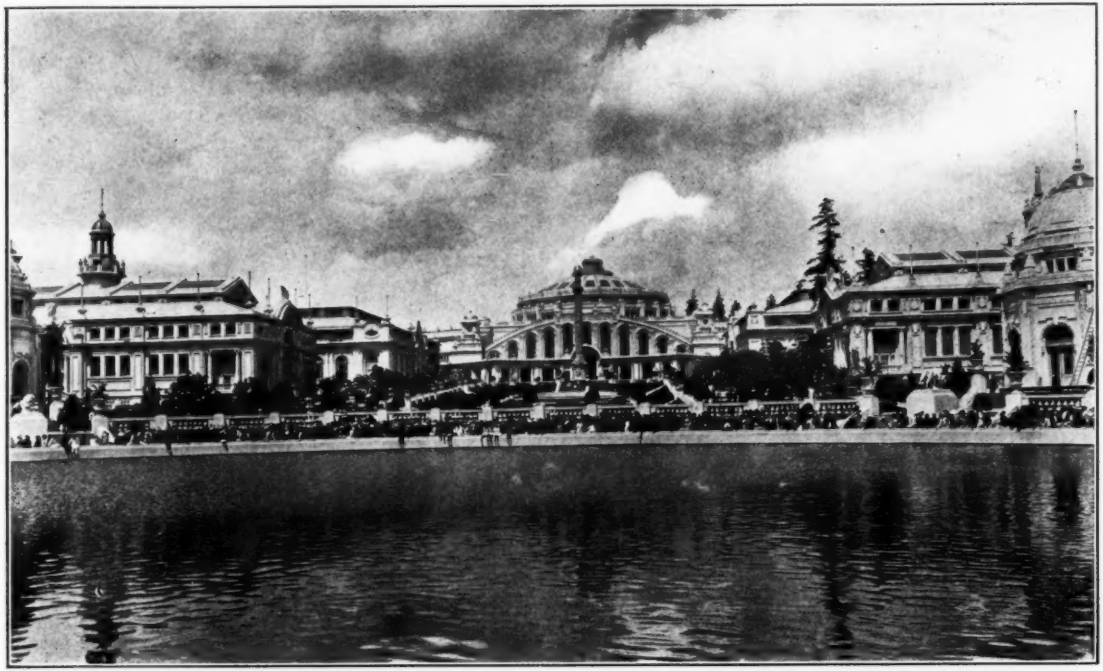
50-watt meridian lamps screwed into sockets cast within the staff ball. The effect has proven very satisfactory. The current for all lighting and power is furnished by the Seattle Electric Company from its new 6,000-kilowatt sub-station located on the exposition grounds. Part of the current is brought from the water plant at Electron, 50 miles distant, over 50,000-volt 3-phase transmission lines and the balance from the Georgetown steam-turbine plant at 13,800 volts, 3-phase. At the sub-station the voltage is stepped down to 2,300 volts and distribution made around the grounds by underground system to various centers where transformation again takes place to 234 117-volt 3-wire secondaries.

A very beautiful electrical effect is obtained at the Cascades by giving rainbow series of coloring to the six waterfalls. By means of a reactance coil designed and wound especially to carry the full load of the Cascade lighting, all the lights are alternately brought on from darkness to full brilliancy twice each minute. Accentuating the

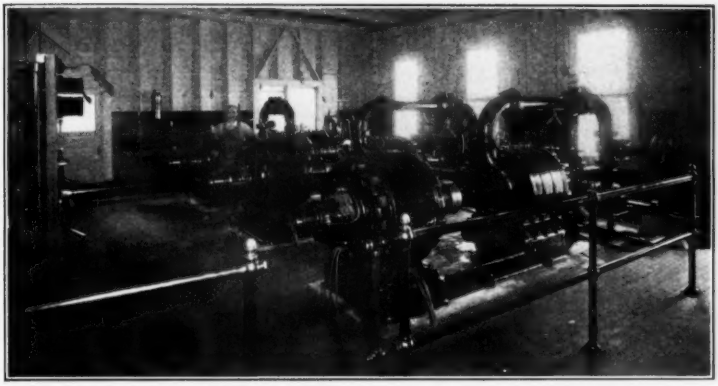


A PANORAMA OF THE EXPOSITION. COMPLETING THE VIEW OPPOSITE.

Machinery Hall Canadian Agriculture
Manufacturers Music European Alaska



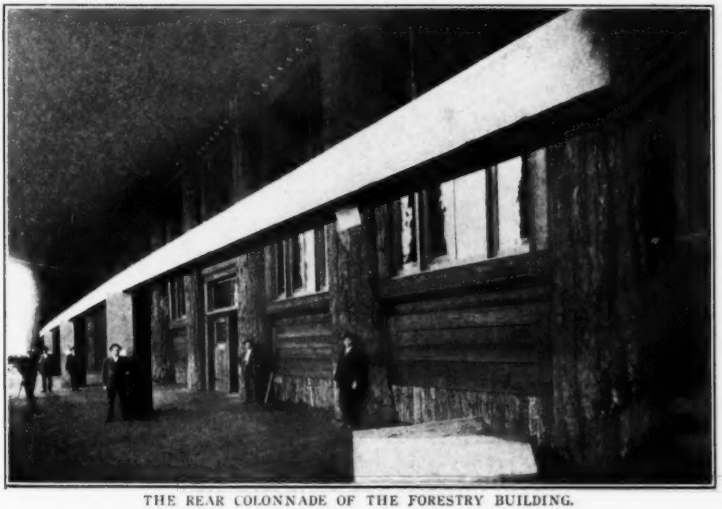
LOOKING UP THE COURT OF HONOR, FROM THE MAIN GOVERNMENT BUILDING.



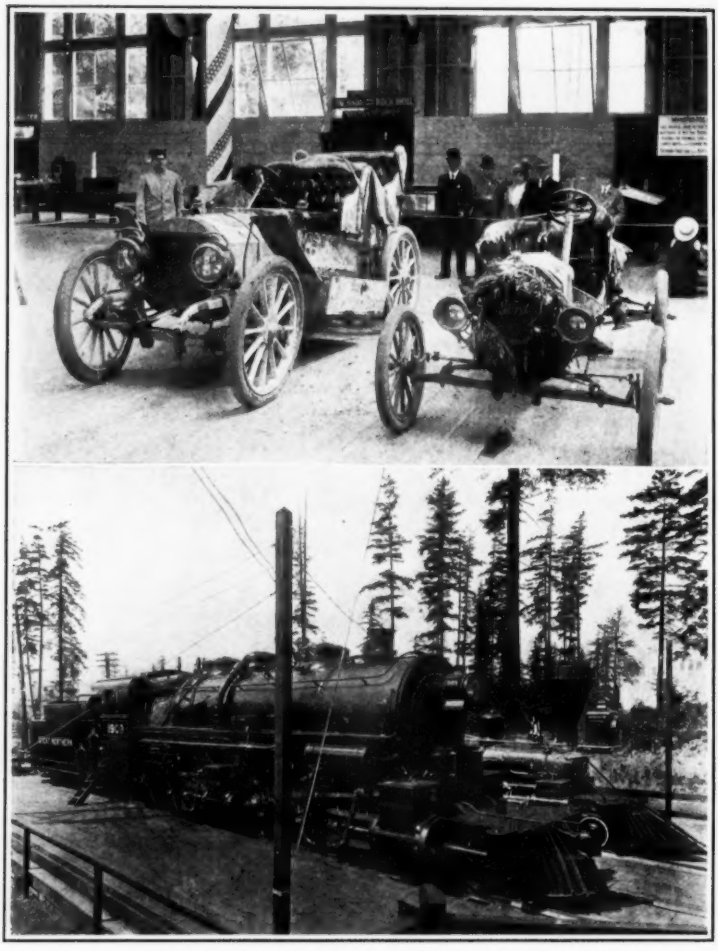
THE EXPOSITION PUMPING PLANT, FOR FIRE PROTECTION AND GENERAL SERVICE.

Alaskan side of the Exposition are totem-pole electroliers scattered at various points about the ground, these being specially designed for this purpose. A beautiful effect is obtained in the trees of the natural park extending for nearly a mile along Lake Washington front by the thousands of lights which have been scattered through the branches in bewildering profusion.

Of equal interest to the mechanical and electrical engineer are the pumping plants. Because of shortage of city water it was necessary to



THE REAR COLONNADE OF THE FORESTRY BUILDING.
The timber exhibited is 18 in. square and 160 ft. long.



MECHANICAL AND TRANSPORTATION EXHIBITS.

Above, the leaders of the New York-Seattle Road Race—June 1, 12.04-June 23, 12.56. Below, Great Northern locomotives No. 1 and No. 1909.

install a complete plant for irrigation and fire-protection purposes, and for these purposes three direct-driven pump units were used. Each is capable of delivering 1,000 gallons per minute against a pressure of 250 pounds. The motors are Westinghouse 2-phase 2,300-volts;

the pumps are Worthington 4-stage centrifugal, and the pipe and fittings Crane Co. Another plant consisting of two belt-driven units for working the Cascades and Geyser Basin was installed on the main grounds. Here Krogh Mfg. Co. centrifugal pumps and Allis-Chalmers motors, one 50 horse power and one 100 horse power were used. The main intake and discharge pipes are wood-stave of local manufacture, 20-inch and 18-inch respectively. By an ingenious arrangement of the discharge end of the 6-inch fountain supply pipe, the water is made to spout like a geyser while the flow of 12,000 gallons per minute over the Cascades is also broken up so as to give the effect of twice its real flow.

EXHIBITS.—In the newer countries the pursuits are necessarily inclined to agriculture. It is not strange, therefore, that many of the best exhibits are along these lines. Fruit products for which Oregon and Washington are noted are especially in prominence.

The government exhibits are more complete than ever before and occupy more floor space than at any previous exposition. A working exhibit of the telepost system is in evidence, as well as a working model of the automatic violin and organ—an electrically operated mechanism which gives wonderfully beautiful and correct music. X-ray and medical apparatus and a comprehensive forestry exhibit are all of interest to the engineer. Everywhere about the grounds the educational aspect of this exposition is evidenced by the unusual number of lecture rooms fully equipped with stereopticon lamps and other facilities for the daily and hourly lectures. The Forestry building is full of pleasing exhibits, but none more striking than two timbers at the rear, one a piece 18 inches square and 160 feet long, and another 54 inches square.

The display of locomotives attracts the mechanical engineer, especially the pair furnished by the Great Northern Railway—one the pioneer wood-burning engine No. 1, the other the latest compound articulated type designed for oil burning and weighing complete a half-million pounds. The draw bar pull is asserted to be 13 times that of the pioneer, and one is prepared to accept the statement.

The electrically inclined will find interest in the complete display furnished by the General Electric Company in the Machinery building. All classes of lighting apparatus and small power machinery are shown, as well as a large electric cooking outfit. This is complete for every conceivable purpose. The Roebling Company exhibit is in this building and is also very attractively arranged.

The mecca of the mining men is the Mines building, wherein are shown the mineral wealth and resources of Washington and Idaho.

The exhibits include all kinds of clay, stones, minerals, and ores. Of the latter, samples of gold assaying $24,000 per ton are shown. These are noted to have come from a certain Washington mine that two years ago was sold for taxes. The crude and the finished product of the Washington Portland-cement industry are shown and the statistics give the present daily output at 2,400 barrels, while the supply of raw materials is sufficient at convenient points to make a daily output of 2,400,000 barrels easily possible. Samples of ores from all the counties of the State are shown giving a combined representation of over 200 mines. An exact model of a coal mine is an interesting feature. The whole exhibit is meant to be of distinct service to the people in a very practical way, for the people of the State are invited to send soil, clay, and ore samples for analysis in order that they may know to what any given clay, etc., is adapted. The mineral wealth as well as the agricultural wealth of these northwest States is extremely diversified, as is strikingly shown by the exhibits. The rich Cœur d'Alene district of Idaho is well represented by large and valuable exhibits. In the Mines building are given daily demonstrations of mines rescue work, and various new mining machinery is shown.

The world has regularly been informed through the press of the gold shipments reaching Seattle from Alaska yearly. A display cage in the Alaska building containing $1,100,000 of Alaska gold in various forms makes these reports seem more real.

At the foot of Pay Streak is an amusement feature that gives promise of a commercial importance. The Vacuum Tube Railway is an adaptation of the department-stores cash tubes, the cylinder being designed to carry people instead of money. The experimental track is about 2,700 feet long and a car containing 10 people is taken by suction through this length at the rate of 30 miles per hour. A 75 horse power motor driving an exhaust fan is the motive power, and speeds up to 150 miles per hour are promised by the promotors.

No description however technical would be complete without special mention of the landscape architecture. Never before in this country has such a wealth and profusion of flowers and shrubs and trees been gathered together as are now in full beauty, and the wizard of Olmstead Brothers, Mr. James F. Dawson, who has had this work in charge, has so planted and arranged that flowers of some kind will be in this same gorgeous abundance throughout the period. As an indication of what has been done it may be stated that over 1,500,000 pansy plants, 35,000 geraniums, and uncounted roses and other flowers are now in bloom on the grounds. The Formal Gardens below the

Geyser Basin are a remarkable development and contain floral specimens that never before have been grown. The floral display is probably the most striking feature of this Exposition.

CONCLUSION.—In conclusion it is fitting to look into the future and endeavor to forecast the results of this Exposition. The benefits should be threefold, viz:—educational, constructive and financial.

The educational features are everywhere in evidence. Almost every building has a lecture room and a stereopticon which are daily being used by experts in their lines to tell visitors of the wonders of the Northwest. All exhibits have been gotten together and arranged with this same predominating idea, and thus must the Eastern visitors especially take away with them a living conception of the Northwest country such as they never before dreamed of.

The constructive side of this Exposition must follow because first of all thousands will be attracted here by what they have seen. The significance of this enterprise is also of special moment in connection with the University of Washington. With a superb location and already well provided with buildings and equipment, it will next Autumn find itself in possession of some $2,000,000 more of practically permanent structures and grounds, all constructed on such large scale as will provide for much further growth. The University may retain any building it desires and probably will designate about twelve, which range in value from $200,000 to $10,000 each. What all this means to educational interests can be best appreciated by those who know how difficult the early growth of a State university usually is.

As to financial results not much can be said. As a business enterprise the fair has thus far been a success. It has been run on absolutely business principles, with rigid economy, so that the start was made right. Up to June 1, the total attendance was nearly 700,000, which is way ahead of the early estimate, and it now seems probable that 3,500,000 admissions will be the final total, or nearly double the original estimates. With this attendance the exposition may easily prove in itself a financial success, and if so it will be a record-maker. The larger financial success is assured, however, because of what will come indirectly to the Northwest, to Washington, to Seattle, and to the University of Washington. The A. Y. P. Exposition will go down in history as the most successful Fair ever held, and in no small measure will this be due to the fact that it was "The Fair That Was Ready on Time."

THE STEAM TURBINE AND THE RECIPROCATING ENGINE FOR MARINE PROPULSION.

By Ira N. Hollis.

In two articles published in our April and May issues, Professor Hollis reviewed the history of the design, manufacture, and installation of the low-pressure steam turbine and discussed its economic importance as an adjunct to the reciprocating engine in stationary steam plants. The second phase of his argument has broadened to include the entire question of the turbine in marine service, either in conjunction or in competition with engines of the older type. Last month's installment was concerned with examples; this month's concludes the discussion with formulated deductions.—THE EDITORS.

THE chief difficulty in the way of the steam turbine has been the screw propeller. Certain sacrifices in efficiency have been necessary in adapting the two to each other. While the turbine can be designed for low speed, its size and weight then run up too much for marine practice and it no longer compares favorably with the reciprocating engine except in economy. The number of stages in the Parsons machine grow greater as its rotative speed grows less, so that the casings and disks stretch along the shaft inordinately. The inventor found this true even for the high speed at which the turbine was run, and he placed the successive groups of stages in different casings on separate shafts as explained before. The Curtis turbine, on the other hand, is usually increased in diameter for low rotative speed. This adds rapidly to the weight on the shaft and becomes prohibitive below a certain speed. We thus have the curious paradox of more turbine for low speeds than for high. Up to this time, no marine turbine has been designed for the low rotative speed of the reciprocating engine of freight ships.

Given, then, a limit of weight for the power demanded by a ship, the turbine requires for economical performance much higher rotative speed than the steam engine. Its whole efficiency is dependent upon high speed unless excessive weight and complication are permissible. The screw propeller is exactly the reverse. It must be run at low speed to avoid great frictional and slip losses. A compromise then follows by which both the propeller and turbine are sacrificed for a speed at which they work together with greatest economy. The truth is that erroneous conclusions are easily reached by separating

the two in comparing the performance of the ships equipped with different types of propelling apparatus. The prime mover and the propeller must invariably be treated as a unit.

Another consideration is that the turbine falls off more rapidly in efficiency than the steam engine as the speed decreases. For this reason, it is not specially adapted to war vessels which usually steam at only half-speed. Cruising turbines have been added by Mr. Parsons, which is only another method of increasing the number of stages for low rotation of the shaft but it is doubtful if even this addition serves the purpose. So far, the reciprocating steam engine has the advantage at low speeds in all classes of ships.

A few examples of sister ships using different types of propelling machinery will serve to show the relative rotation speeds. Among these the most interesting are the three scout cruisers, Birmingham, Salem, and Chester, fitted respectively with triple-expansion engines, Curtis turbines, and Parsons turbines. The data in the small table are taken from the acceptance trials, as the results of the recent tests are not yet available for publication. The German cruisers are taken from a paper by Mr. Bauer.

	Name of Ship.	Type of Engine.	Speed in Knots.	Revolutions per Minute.	Percentage Slip of Propeller.
1.	Birmingham	Reciprocating	22.5	172.1	12.65
2.	"	"	24.33	191.7	15.8
3.	Salem	Curtis Turbine	22.5	312.5	16.17
4.	"	" "	25.95	378.	20.28
5.	Chester	Parsons Turbine	22.5	473.	18.46
6.	"	" "	26.52	614.	25.56
7.	German Cruiser	Reciprocating	23.	143.	
8.	" "	Parsons Turbine	23.	528.	
9.	" "	Reciprocating	24.	187.	
10.	" "	Curtis Turbine	24.	335.	

The total indicated horse power for all machinery, including auxiliaries, on the Salem was 10,836 at 22½ knots. This was obtained by adding 10 per cent to the shaft horse power recorded by the torsion meter. On the Birmingham the power for all purposes was practically the same, being 11,098 at 22½ knots. The power on the Chester was not recorded owing to some defect in the measuring apparatus.

In the case of the first two German cruisers the shaft power of the Parsons turbine exceeded the indicated power of the reciprocating engines by 10 per cent while for the second two the reverse was true,

the Curtis turbine requiring 11 per cent less power on the shaft than the indicated power of the reciprocating engine.

Comparisons of this kind are very unsatisfactory, however, as the relation between the indicated horse power of the reciprocating engine and the effective power on the shaft depends upon too many facts to be well-known for any special case, except after extensive experiments for the purpose of ascertaining accurately the work lost in friction. Besides, it is very difficult to take account of the effect of different designs of screws upon the hull resistance. No two ships have exactly the same auxiliaries and no two crews ever work with precisely the same efficiency. Consequently no fair bases of comparison have yet been established and the results are likely to be inconclusive.

The only sound conclusion to be reached from the data at hand is that in the matter of power, weight, and economy there is little to choose between the reciprocating engine and the turbine for speeds between 20 and 25 knots, with perhaps a preponderance in favor of the latter. Below 20 knots the results are largely in favor of the former. The Birmingham's engines will probably be found to gain over the other two in economy and ease of handling as the speed decreases. But this is not the whole question for a man-of-war. Her maximum speed may be required for only short intervals or in emergencies, but when it is needed, it is needed badly; consequently, the machine which will maintain that speed reliably will invariably be chosen. There is another aspect of the case for battleships and armored cruisers and that is the vibration. A steam engine may be balanced for the reciprocating weights, but it cannot be balanced against variations in the turning moment, and therefore any ship using it will be subject to vibrations against which the steam turbine is perfectly free. Another thing, the latter drives a smaller screw and the immersion can be made deep enough to lessen the throb of the propeller materially so that vibration from that cause may in large part be eliminated. The vibration is of small moment in a freight ship and it is not of primary importance even in a passenger ship; but it may become very serious in battleships if it interferes with sighting the guns while moving at high speed. On this issue the turbine should undoubtedly be selected for all heavily armed ships.

The types of ships for which the turbine is to be preferred to the reciprocating engine are war vessels and passenger ships of high speed, but it must be remembered that by far the greater part of the world's commerce is carried in freighters of very moderate or low

speed. For these the reciprocating engine must be used until a more efficient turbine at low rotative speeds can be designed, or a more efficient propeller at high speeds. The three-cylinder triple-expansion engine occupies this great field admirably. The exact speed at which it should give place to the turbine has not yet been worked out for different classes of ships. The deciding factors are probably displacement and shape of hull, together with the arrangement and design of propellers.

The last word has not been spoken about either method of driving ships. It is possible that few more large reciprocating engines will be built for ships exceeding 20 knots in speed, and that few turbines will be used in freighters and other vessels with a speed of 15 knots or less. Between 15 and 20 knots the field is open to either.

A compromise in the nature of a combination of the two, giving to the steam engine the high-pressure part and to the steam turbine the low-pressure part, may ultimate become the standard method of propulsion excepting for very high or very low speeds. This combination has been tried with very favorable results in several cases. It was used first in the Velox, a torpedo destroyer built for the Parsons Marine Steam Turbine Company in 1903 and sold to the British Admiralty. Two triple-expansion reciprocating engines of 150 horse power are coupled to the central shafts carrying the low-pressure turbines. For cruising the steam enters the two steam engines and passes successively through the outside wing turbines and the central low-pressure turbines. For high power, the steam engines are uncoupled. When the low power of the reciprocating engines, 300 horse power, is compared with the 10,000 developed by the turbines, the installation in the Velox becomes a very poor test of the combination.

A torpedo boat built by the Yarrow Company in 1903 had a triple-expansion engine on the centre shaft for cruising purposes and led the exhaust direct to the condenser. The engine was entirely independent of the turbines on the wing shafts, and was therefore not used in combination with them. These turbines were of the Rateau type and this boat made on trial 26.39 knots with the reciprocating engine at 576 revolutions per minute and the turbines at 1,300.

The first real test of the combination for marine service was in the Otaki, built in 1908 for the New Zealand Shipping Company. She is said to be about 10 per cent more economical than her sister ships, the Orari and Opawa, fitted with reciprocating engines. The best example of the combination is afforded by the White Star Liner

Laurentic built for the British-Canadian service. The ship is 565 feet long by 67 feet beam and 14,500 gross tonnage. There are three screws. Each wing shaft is coupled to a four-cylinder triple-expansion engine of 7,800 horse power and the centre shaft is driven by a low-pressure turbine of 4,600 horse power. There are two condensers used for the turbine, or for the exhaust of the wing engines when the turbine is not running. A large change valve in the exhaust nozzle of the steam engines enables the engineer to turn the exhaust quickly from the turbine to the condenser when reversing. The total horse power is about 20,000 and the ship is to make 18 knots. The steam engines in this arrangement seem rather large for such a combination but the designer was probably influenced somewhat by the requirements for navigating the St. Lawrence River.

The types of ships to which this combination seems to be specially adapted are high-speed cruisers and battleships which usually cruise at low speed for the purpose of saving coal. Several possible arrangements and designs of machinery suggest themselves. Those adopted for the Laurentic would be satisfactory, but the proportion of power on the triple-expansion engines is too great. The best general design would probably be two three-cylinder compound engines on the wing shafts with a low-pressure turbine on the centre shaft capable of taking half the power at full speed. For maximum power live steam might be turned into all the cylinders with the exhaust going to the turbine. For small speeds the wing engines could be used as compound with the exhaust going direct to the condenser, and the centre screw uncoupled.

A method of transmission by electricity has been suggested by a number of engineers as the best solution of the marine problem, and recently a paper by Mr. W. P. Durtnall before the British Institute of Marine Engineers has presented the case in concrete form. He proposes high-speed turbines to drive generators from which the current passes to motors on the main shafts. He would use polyphase alternating currents with synchronous generators and squirrel-cage induction motors for the purpose of keeping down weight and promoting efficiency of transmission at a number of speeds. One example worked out with a view to determining the actual weight of machinery for a 4,000-horse-power ship gave 20.5 pounds per shaft horse power. This is heavier than for all-turbine propulsion, but inasmuch as there will be greater economy in the use of steam for all speeds the reduction of weight in the fire room will more than offset the increase in the engine room, and the total weight chargeable to

propulsion will be less than that for all-turbine or all-steam-engine installations. The calculation is entirely theoretical and for that reason it is not convincing. The problem will have to be tried out practically at sea before Mr. Durtnall's figures can be accepted with confidence; nevertheless the system proposed would be ideal in many respects. The motors could be designed for the most efficient propellers and then a combination good for all speeds might be worked out. One very great advantage in this system would be complete control of the ship as a whole from the pilot house. The motors could be reversed by a switch and the fire-rooms could generally be warned through voice tubes about the demand for steam. The turbine installation would be exactly like that of any electric-light station.

Another system, mentioned in THE ENGINEERING MAGAZINE for April, would be the combination of steam engines, turbines, generators, and motors. By this, the two screws would be operated primarily by two compound or triple-expansion engines discharging the exhaust into low-pressure turbines, which in their turn would drive generators instead of screws. By then turning the current into motors on the main shafts, the steam engines could be assisted to any desired extent for going ahead or astern. The flexibility and economy of this system recommends it especially for cruising vessels which are seldom run at maximum speed.

Other systems have been suggested; in fact, when the producer and gas engine are added to the list, the probable outcome of the keen competition for the field cannot be predicted. The whole subject of marine propulsion is in such a state of flux that anything may survive. It is possible that the steam engine may take a new lease of life for high-speed ships and come back to its own once more. While all sorts of schemes are put forward, one test should invariably be applied; that is, the probability of derangement or breakdown. That probability is increased more than in proportion to the number of links between the boiler and the propeller. It is just like multiplying a number of efficiencies together—the ultimate efficiency, as well as the ultimate reliability, is less than that of any single link. Consequently, the all-turbine or the all-steam-engine machine is to be preferred on board ship to any combination for effecting economy, unless the gain more than offsets the loss from probable repairs. One of the most useful devices for marine work would be a thoroughly reliable, noiseless gear of high enough efficiency to make it worth using with a very high-speed turbine. If it could be designed

for variable speed as well as reversing, the steam turbine would soon replace the steam engine in all classes of ships.

An interesting example of the system proposed by Mr. Durtnall applied to a special case, is in actual use for the Chicago fire-boats Joseph Medill and Graeme Stewart, designed by Mr. W. I. Babcock. There is a central station of two 660-horse-power Curtis turbines direct connected to two 220-kilowatt direct-current generators and two-stage centrifugal pumps. The current from the generators is conducted to variable-speed motors on the two propeller shafts. The motors can be controlled from the pilot house, as well as from the engine room, and the captain can easily direct the movement of his boat without signalling to the engineer. When the ship is going to a fire the power can be thrown on the generators and motors by letting the centrifugal pumps remain dry, and when lying still, the whole power of the turbines can be used in pumping water. The test of these ships gave very satisfactory results both for propulsion and pumping. The weight of machinery does not appear in the report. That was in this case not a controlling factor, and yet the total weight of machinery boilers and pumps was doubtless taken into consideration.

RECENT DEVELOPMENTS IN CONVEYING MACHINERY FOR COAL AND ASHES.

By Wilbur G. Hudson.

On account of the fullness of Mr. Hudson's discussion and the large volume of illustration, his article has been divided between two issues. The first part, published in July, covered the general characteristics of belt and chain conveyors and rigid bucket carriers and took up typical installations for coal conveying and the general problems of boiler-plant coal handling. This month's installment concludes the review with a consideration of storage facilities, special installations, automatic weighing, and ashes handling.—THE EDITORS.

WHERE the power-plant location permits, the overhead-bunker storage should ordinarily be supplemented by an outdoor ground storage as a reserve. The locomotive crane with automatic bucket offers about the cheapest method of stocking out and reclaiming. The crane will cost about $6,000, and there will be in addition usually the cost of a dumping pit for cars and the crane track, making an additional $500 or $1,000. Where an extensive ground storage is desired, the crane must be supplemented by some form of conveying system to attain any satisfactory rate of handling.

Two examples will suffice:—The coal-handling system of one of the Boston Elevated Railway Company's power houses, with a consumption of about 3,000 tons per month (Figure 15), consists of an overhead storage bin served by a 50-foot inclined continuous bucket elevator, which discharges into a reversible suspended-flight distributing conveyor of 160 feet centers. For reserve storage a 30-foot radius locomotive crane on a circular track handles coal from cars to stock pile, and back into the elevator boot when required. Power and costs are as follows:

Conveying system:—Power required, 15 kilowatts. One man attends to conveyor. Repairs average two-tenths of a cent per ton handled. Cost of handling, including power, supplies, attendance and repairs, 3 cents per ton. The crane when in service costs an average of 3 cents per ton handled, for power, attendance, repairs and supplies.

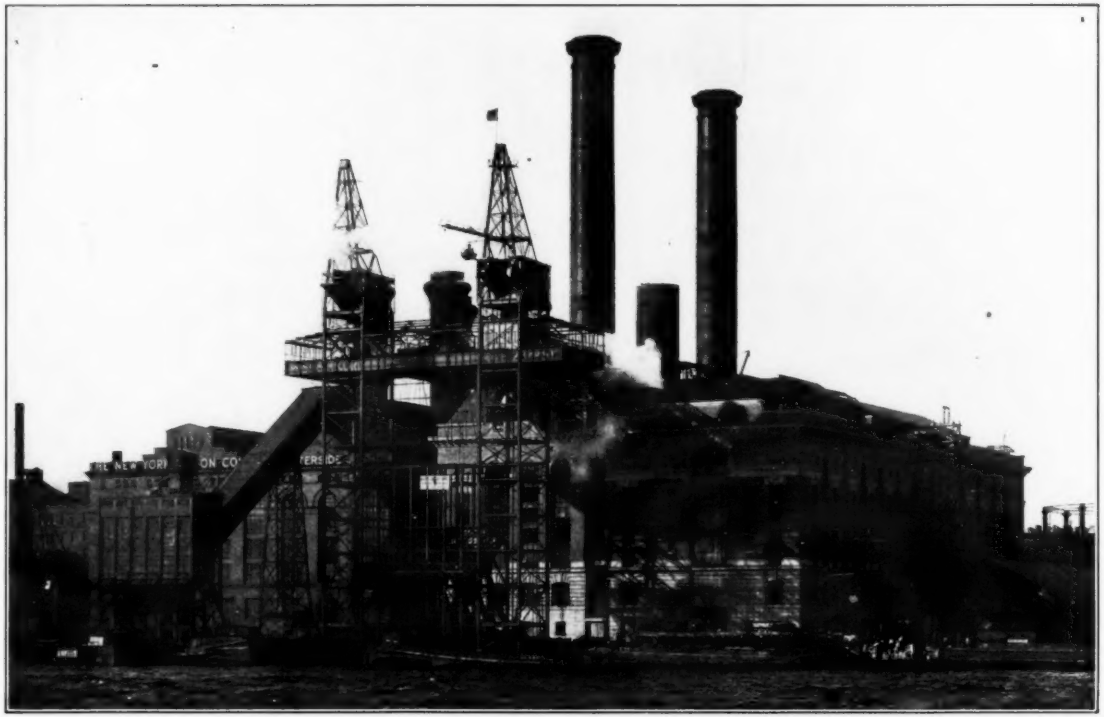


FIG. 14. WATERSIDE STATION NO. 2, NEW YORK EDISON COMPANY.
Equipped throughout with Mead-Morrison machinery for handling both coal and ashes. A McCaslin conveyor takes ashes from the dock level and deposits them in overhead ash storage on the water front underneath the coal towers.

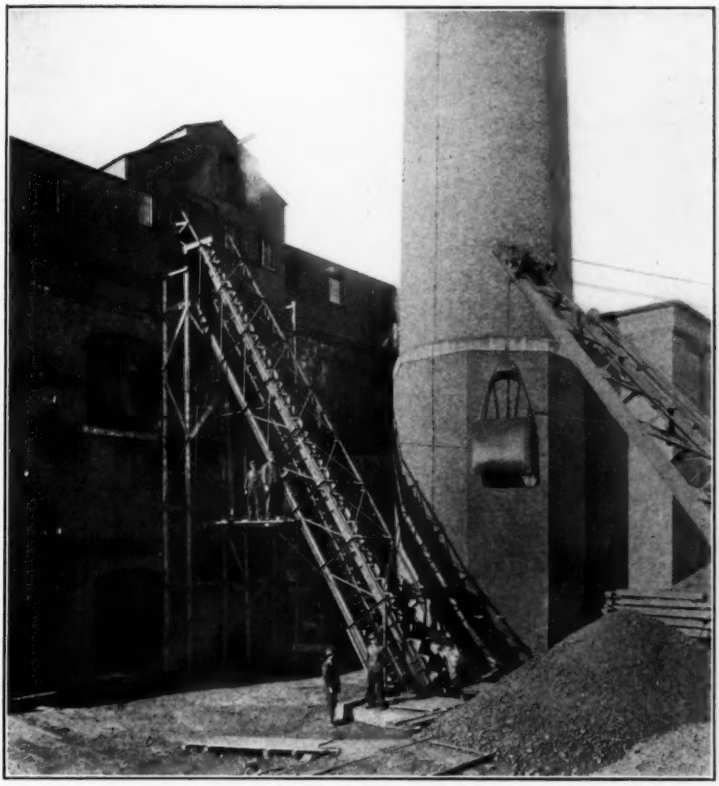


FIG. 15. ELEVATOR SERVED BY LOCOMOTIVE CRANE FROM STOCK PILE, BOSTON ELEVATED RAILWAY.

As an example of a larger and more complete system the Second Street power plant of the Brooklyn Rapid Transit Company is interesting. The storage bunkers are at a considerable elevation above the wharf, and transfer from wharf to bunkers is made in one operation by means of duplicate 24 by 24-inch pivoted-bucket Peck carriers.

Coal is unloaded from boats either by the hoisting tower operating a 2-ton clamshell bucket, or by locomotive cranes, and is delivered to either or both of the pivoted-bucket carriers extending back from the wharf 200 feet, then vertically 110 feet, and horizontally 180 feet over the bunkers. These carriers operate at a speed of 54 feet per minute and have a full load capacity of 90 tons per hour each. Power consumption, light 10 horse power; loaded, 22 horse

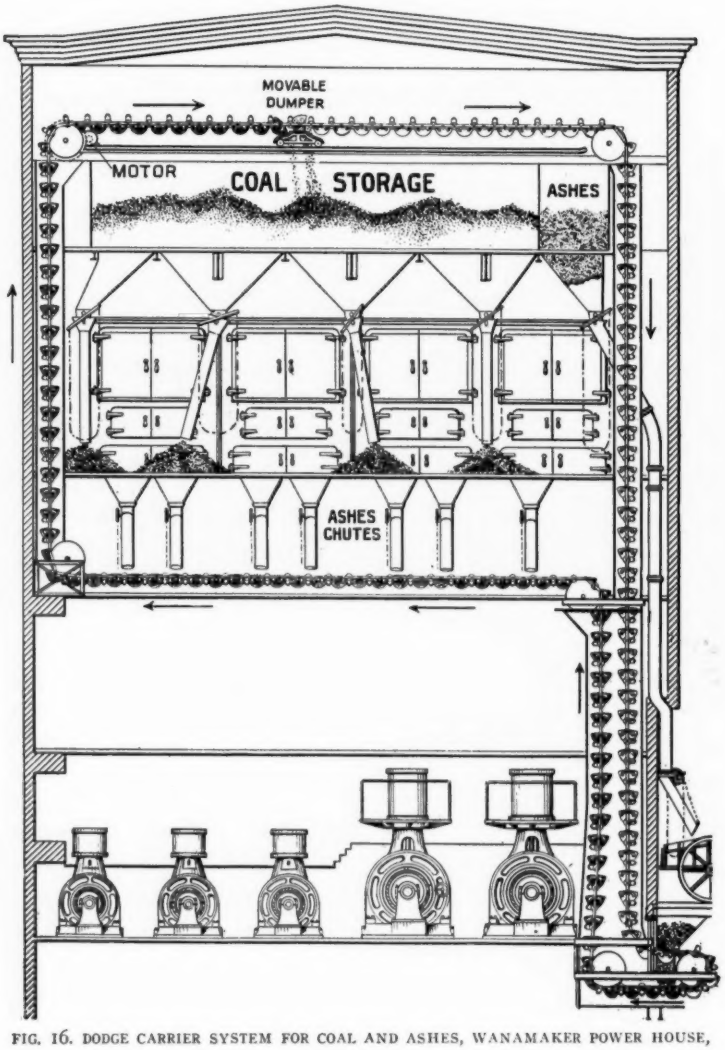


FIG. 16. DODGE CARRIER SYSTEM FOR COAL AND ASHES, WANAMAKER POWER HOUSE, PHILADELPHIA.

power for each machine. The efficiency is very high and the cost per ton handled for power, supplies, and attendance remarkably low, namely, one-tenth of a cent per ton. Steam sizes of anthracite are handled.

Adjacent to the power house is the reserve storage of 100,000 tons. A Robins belt conveyor carried on a timber trestle stocks out coal, and reclaiming is accomplished by another Robins belt conveyor in a tunnel beneath the pile, assisted by a locomotive crane after the portion (about 50 per cent) which will flow directly, is rehandled. This tunnel conveyor in turn delivers to another belt which discharges into the pivoted-bucket carriers already mentioned. Stocking out and rehandling by this method will run about 3 cents per ton for labor, power, and supplies, exclusive of the cost of unloading from boats, which by unloading tower or crane costs from 2 to 3 cents per ton.

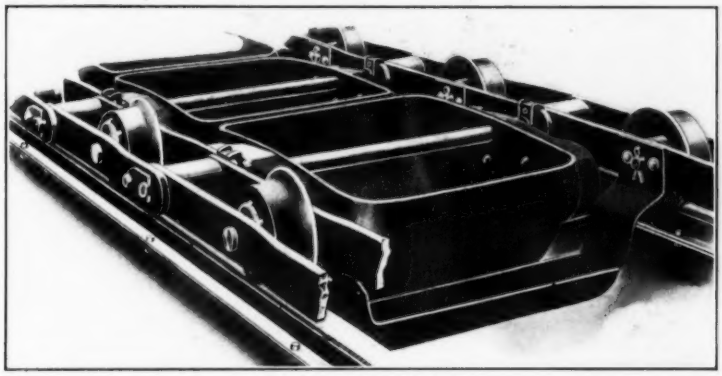


FIG. 17. DODGE CARRIER.

PIVOTED-BUCKET CARRIERS.—Where the design of the plant requires conveying machinery adapted to the combined service of handling coal and ashes, the pivoted-bucket carrier is hard to excel. Ashes handling is very hard on conveying machinery, and the construction of the carrier permits replacement of the several parts as corrosion or wear proceeds.

Typical of this combined service is the recent installation in the new Wanamaker power house in Philadelphia (Figure 16). Here the inaccessible position of the storage bunkers makes it imperative that the conveying machinery should be reliable. Coal is delivered by wagons at the street level to a reciprocating feeder, and is carried by a Dodge carrier up and over the storage bins. The lower horizontal run of the machine brings it beneath the ashes discharge gates so that ashes may be handled in the intervals of coaling. Steam sizes of anthracite coal are burned exclusively.

This carrier operates at a speed of 42 feet per minute. The vertical lift is 114 feet. Power required when operating light, 6 horse

power; loaded at 40 tons per hour, 16 horse power, showing good efficiency.

The details of construction are (see Figure 17) as follows: The buckets are of malleable iron, about ¼ inch thick, and 24 by 24 inches in plan. They are carried by through shafts keyed to the outside links. The ends of these shafts form the chain pins. The inner links are bushed to obtain the necessary bearing surface, oil ducts extending into the bearings from the ends of the shafts. The bush-

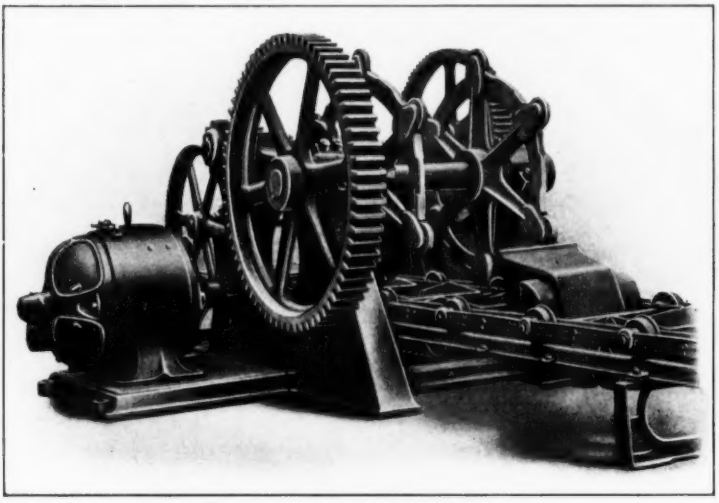


FIG. 18. MC CASLIN DIRECT-CONNECTED DRIVER.
Mead-Morrison Mfg. Co.

ings are protected by chilled cast-iron collars which engage the driving sprockets. The flanged self-oiling rollers spaced midway in the links support the carrier on the horizontal runs and do not engage the sprockets. Auxiliary spill buckets are suspended rigidly between the carrying buckets to catch the leakage at the loading points, returning their load to the main buckets at the next upturn.

Pivoted-bucket carriers for elevating coal in power-plant service have become quite popular. Their advantages are, slow speed, silent operation, adaptability to change of direction without transfer, high efficiency, and easy renewal of worn parts. Their disadvantages are, danger of buckets sticking or upsetting, and jamming in the supports, and the difficulty of preventing spill at the loading and turning points. Protection against jamming may be had by connecting with the driving machinery through a safety pin whose margin of strength be-

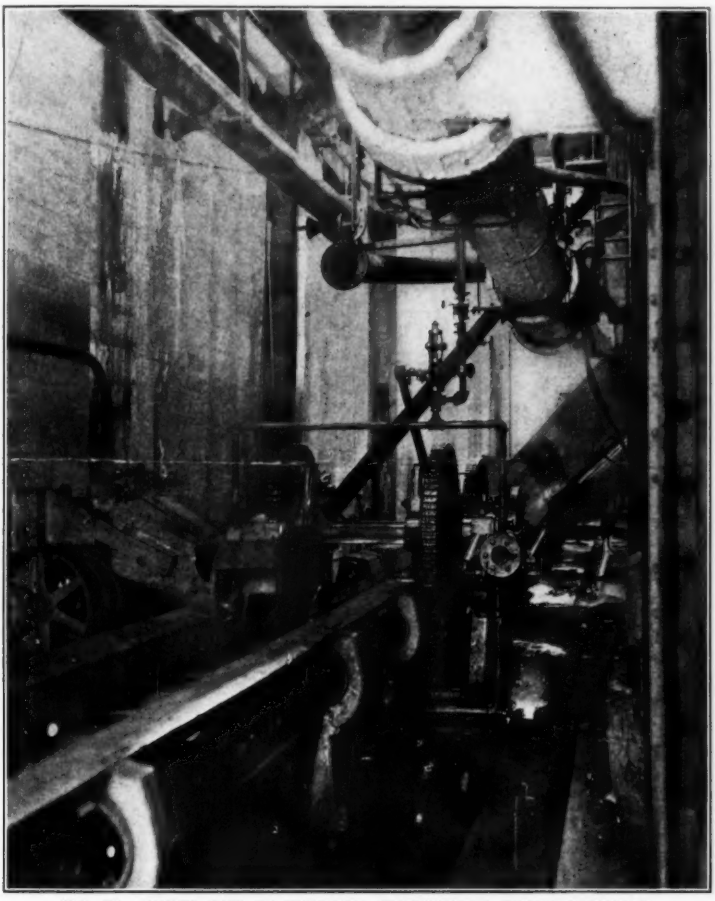


FIG. 19. LOWER RUN OF CONVEYOR, WASHINGTON UNION TERMINAL.
The Anderson type filler takes coal from the cross belts under the track pits.
C. W. Hunt Co.

yond the power requirements is very slight, or better by designing the supports so that the buckets will clear in whatever position they may come around.

Uncleanly loading is guarded against variously in the several latest designs of carriers of which the following may be noted:

In the Hunt carrier (Fig. 19) the buckets are spaced an inch or so apart and are loaded by a special device consisting of a series of connected funnels at the loading chute, in synchronism with and dip-

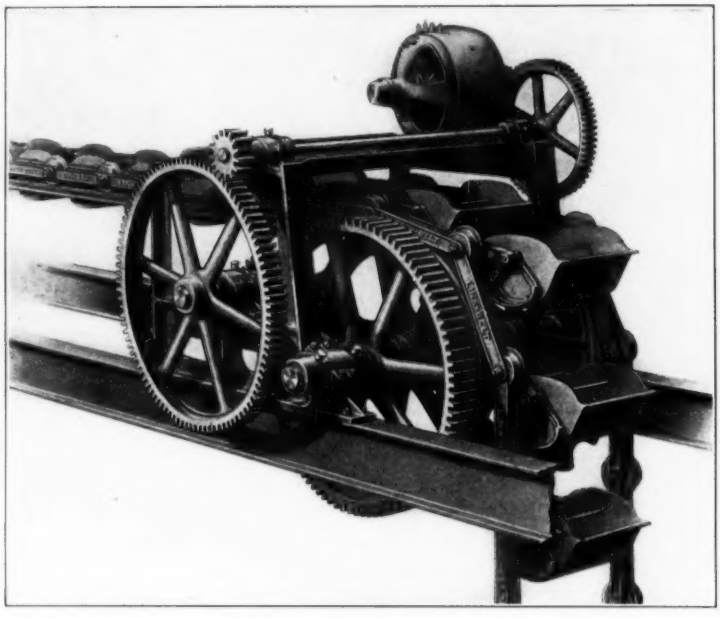


FIG. 20. THE PECK CARRIER.

ping into the carrier buckets, so that each bucket received its proper charge only.

The Webster carrier has buckets with carefully planed lips, and whose pitch is very slightly less than the pitch of the carrier chain links, thus depending on close contact to eliminate the leakage.

The McCaslin carrier (Fig. 18) uses overlapping buckets. These lap the wrong way after tripping for discharge and are reversed by a "righting mechanism" before again passing the loading point.

The Dodge carrier (Figure 17) has small auxiliary buckets hung beneath the apertures between the main buckets to catch the drip and return it to the main buckets at the first upturn.

The Peck carrier (Figure 20) uses overlapping buckets similar to the McCaslin, but they are attached to the links extended beyond the points of articulation, to receive the bucket trunnions. This unlatches the buckets at the turns by giving them a path of greater radius than the chain joints, thereby doing away with a righting device otherwise necessary with the overlapping bucket.

None of these devices for preventing spill at the loading and turning points is particularly effective. The difficulty is inherent in this type of conveyor whose many advantages, however, far outweigh this defect.

The alternative of the pivoted-bucket carrier for handling coal is the standard arrangement of an elevator with rigid steel buckets discharging into a flight conveyor which crosses above the bunkers, and is provided with discharge gates at convenient intervals; or instead of a flight conveyor, a belt with movable tripper. This is a well tried out system, thoroughly reliable, and by many preferred to the run-around carrier on the ground of lower first cost, and simpler construction. The elevator-conveyor system is not adapted to handling ashes, which, however, should be taken care of by separate machinery whenever possible to do so.

Screw conveyors for boiler house service are sometimes used where the capacities are not large. In their favor it may be said, they are compact and lowest in first cost. Against them are the objections negligible in small installations, but increasingly undesirable in larger ones, that they are wasteful of power, unreliable if handling bituminous coal, and of high maintenance costs.

Skip Hoists.—Where coal is delivered by wagon, as occurs often at boiler houses in built-up localities, elevating by a skip hoist is sometimes favored. This consists of a tub holding a wagon load, which is raised vertically, discharging and returning to its loading position automatically. This has given satisfaction for small capacities. The automatic feature is liable to disarrangement if governed by electric or magnetic control, which require very careful adjustment and skilful handling to prevent disaster.

Several designs of skips are on the market, however, in which the control is entirely mechanical and positive, and free from the criticisms noted above.

Skip hoists for coal handling in power plants have no advantages over simple bucket elevators or carriers and in this service are less reliable than are the latter.

Cable ways for transfer of coal are very often employed, but are outside the field of this article.

There are, of course, many variations from the familiar systems of coal and ashes handling in power plants. The Jeffrey Manufacturing Company's installation at the Peoria Gas & Electric Company, is an interesting example. (See Figs. 21, 24). Coal is unloaded from pit or cars by an unloading tower and clam-shell bucket, which discharges into a crusher and thence onto a belt conveyor for dis-

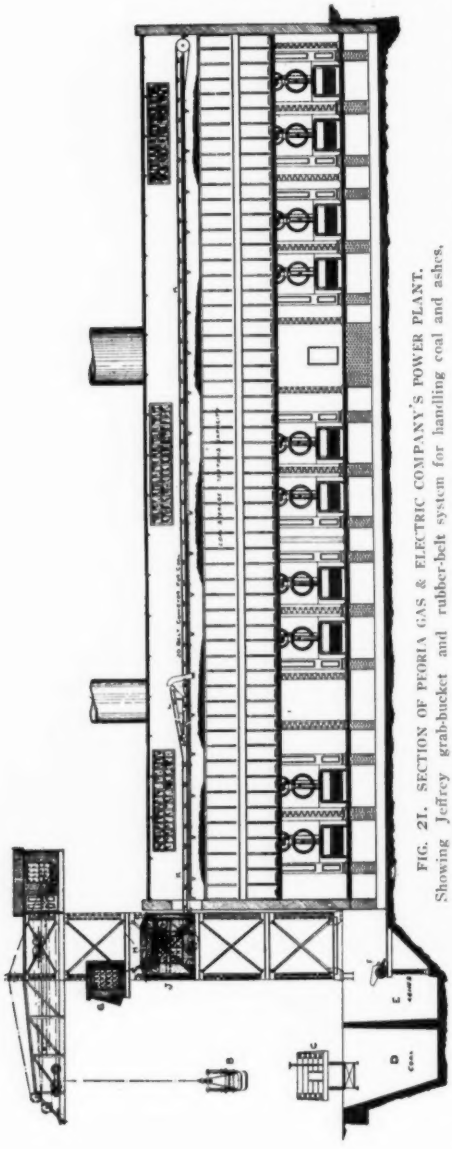
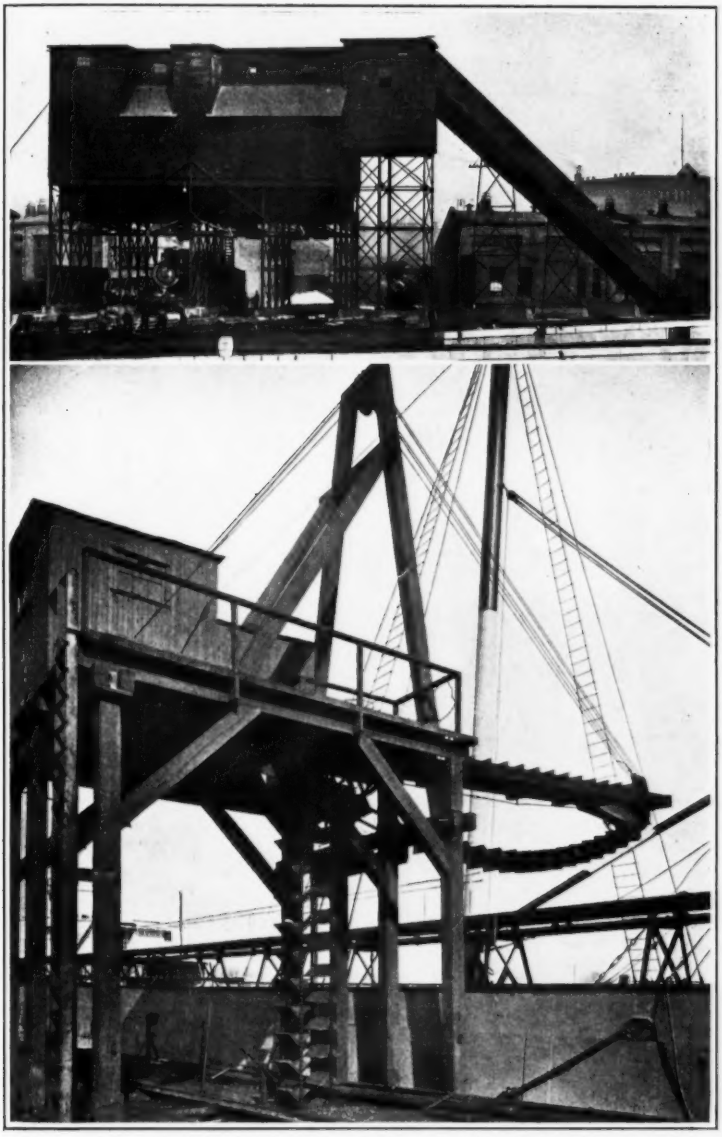


FIG. 21. SECTION OF PEORIA GAS & ELECTRIC COMPANY'S POWER PLANT.
Showing Jeffrey grab-bucket and rubber-belt system for handling coal and ashes.

tribution to the bunkers. Ashes are dumped into a receiving hopper or pit and loaded into cars by the same clam-shell bucket, in the intervals of coaling, or as convenient.

An operating test of the plant on a 30-ton car of screenings showed complete unloading in 25 trips, taking 25 minutes. The power readings at the hoisting tower were: for closing the bucket, 44 kilowatts declining to 28; for hoisting, 72 kilowatts declining to 50; momentary overload of motor, 50 per cent. The trolley motor readings were 15.3 kilowatts in and 15.1 kilowatts out. A comparison of costs of unloading, placing three months of hand labor in 1907 against three months' operation of the tower in 1908, showed a total of 3,984 tons per month under the former conditions at a total cost of 31.28 cents per ton, and a total of 4,428 tons per month by



FIGS. 22, 23. SPECIAL INSTALLATIONS OF WEBSTER COAL-HANDLING MACHINERY.
Above is a locomotive coaling station and ash-handling plant at Allegheny, Pa.; below, a bucket-elevator and conveyor handling coal from railway to vessel, Marcus Hook, Pa.; hinged type two-strand elevator, buckets 20 by 18 by 9 in.; coal is elevated from a track pit, over the boom, and spouted into the hold. One man can raise and lower the boom to clear the masts. Webster Mfg. Co.

FIG. 24. COAL-HANDLING PLANT, PEORIA GAS & ELECTRIC COMPANY.

Jeffrey Manufacturing Co. Bucket capacity 40 cu. ft.; weight 5,200 lb.; hoisting motor 55 h.p., series-wound; hoisting speed 225 ft. per minute; trolley motor 15 h.p.; two-roll crusher, 24 by 30 in., with feeder and by-pass conveyor belt, 20-in. canvas on 3 pulley troughing idlers, with automatically propelled tripper.

mechanical handling at a cost of 14.98 cents a ton (power, *plus* labor, *plus* current at 1 cent per kilowatt, *plus* maintenance at 1 cent per ton), the difference in favor of the tower being 16.3 cents per ton.

Coal Weighing Devices With Conveying Machinery.

When in-coming coal can be weighed in bulk, the question of weighing between receiving hopper and stokers does not enter. But where this is impracticable, as when coal is received by boat, some

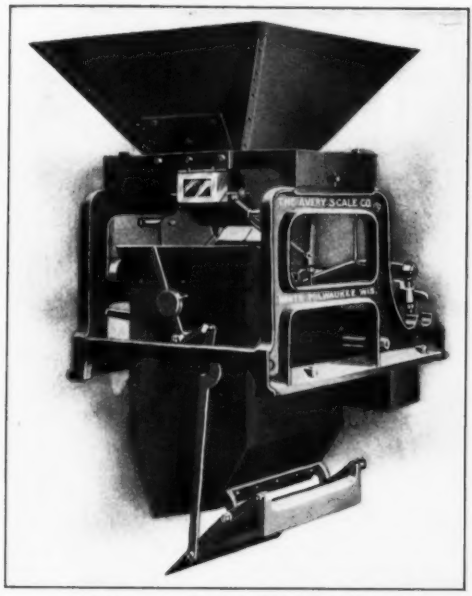


FIG. 25. AVERY CONTINUOUS WEIGHER.

means of weighing is often desired as a check. There are several types of continuous weighers on the market of which two may be outlined.

The Avery continuous weigh scales (Figure 25) is an English invention, and may be installed at any point where there is a transfer of coal with reasonable regularity of flow. A drop-bottom weigh-box is suspended at one end of a lever arm balanced by a counterweight at the other end. A stream of coal enters the weigh-box from a hopper above, through a cut-off gate controlled by the lever from which the weigh-box is hung, so that as the weigh-box is filled, the flow is gradually reduced and finally stopped as the scale beam is exactly poised. The weigh-box doors then automatically open for discharge, and close; the sequence of operations being automatically repeated as long as coal is fed to the upper hopper. The number of weighings, hence the total weight, is registered by suitable recording mechanism.

The Blake-Denison continuous weigher is intended to weigh material while upon a belt conveyor or pivoted-bucket carrier. A section of conveyor, say 20 feet, is suspended from the scale levers and the recording device records the weight of material on this length of belt each time the belt travels 20 feet. Every portion of material is thus weighed. Figure 28 shows the weighing mechanism in detail. A steelyard balanced to suit the unloaded suspension is delicately pivoted so as to rise a distance proportional to the weight on the section of belt being weighed. A gripping lever locks the yard arm in position the instant it takes its position, and a measuring quadrant swings over toward the yard arm until it comes in contact,

then reverses carrying pawls which rotate the ratchet wheel and indicator a distance dependent upon the forward movement of the quadrant, which in turn was controlled by the position of the yard arm. Oscillation of the yard arm is prevented by the mercury dashpot. The gripipng and measuring operations are effected by two cams upon a shaft operated by gears driven by the conveyor itself. The cycle of operations repeats with every 20-foot segment of belt passing. The makers guarantee an accuracy of ½ of 1 per cent.

Ashes Handling.

The satisfactory handling of the ashes of a boiler plant is a much more difficult matter than is the coal handling. Their gritty nature and their corrosive action, destructive alike to lubricants and metals, are annoying features, and the liberal coating which every exposed piece of mechanism receives makes attendance particularly unpleas-

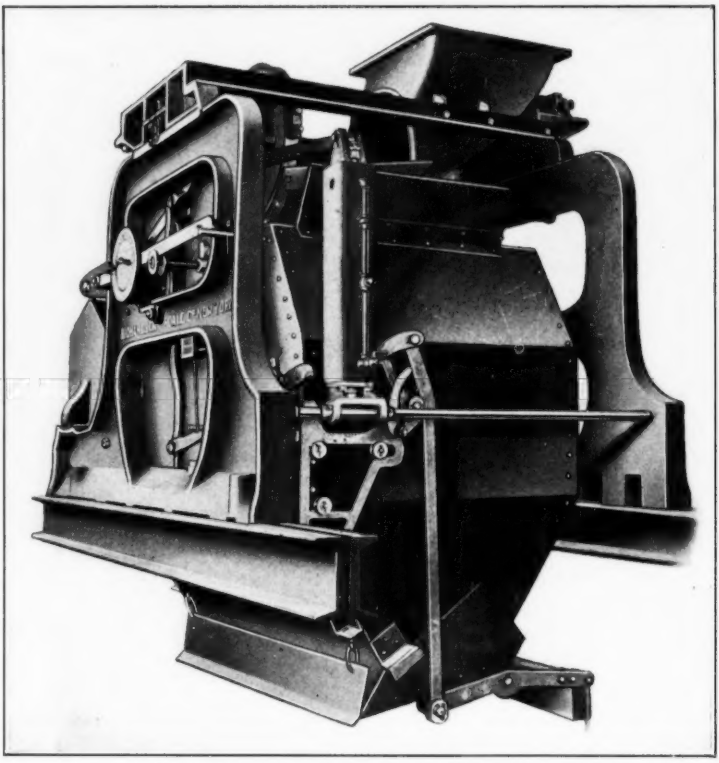


FIG. 26. RICHARDSON AUTOMATIC COAL-WEIGHING SCALE.

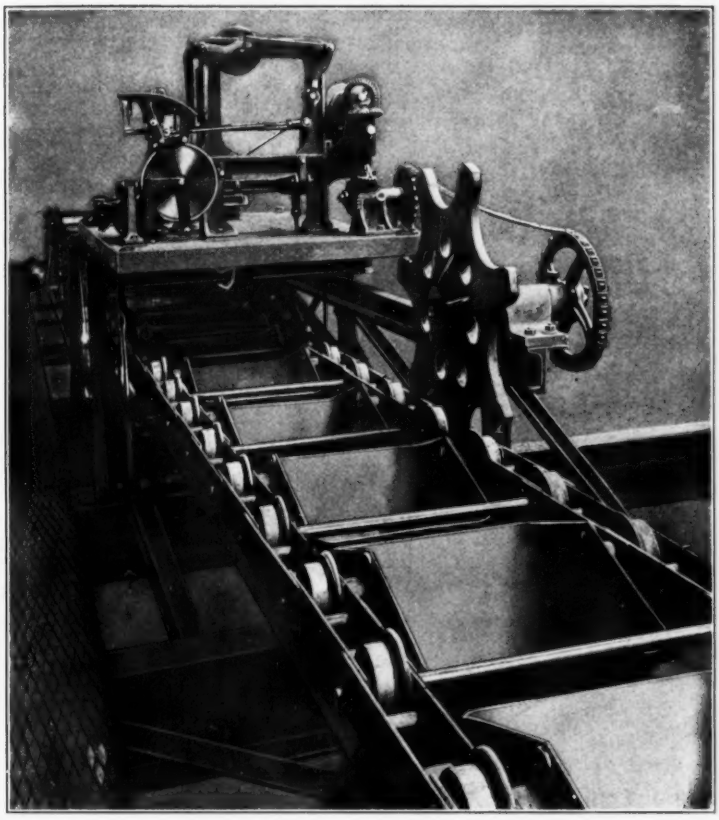


FIG. 27. BLAKE-DENISON CONTINUOUS WEIGHER ADAPTED TO BUCKET CONVEYOR.
Old Colony Street Railway; capacity 60 tons an hour. Weston Engineering Co.

ant. About the only ideal ashes-handling system I have seen is in an isolated colliery boiler house in Pennsylvania, located on a hill-side. A sloping, concrete-lined trench extended through the boiler room in front of the ash pits and a swift running brook had been diverted through this. The ashes were simply raked into the trench, and whisked away. Unfortunately law, nature, and down-stream neighbors, all are opposed to a general adoption of this system.

If a screw conveyor is employed, the standard steel construction is absolutely useless. The special designs with heavy chilled cast-iron blades and cast-iron troughs are usually good for about a year's

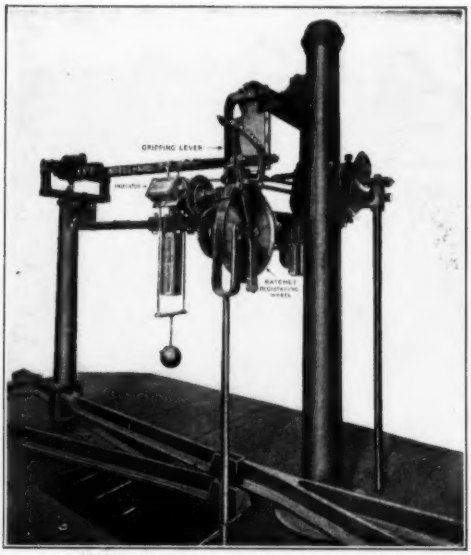


FIG. 28. THE BLAKE-DENISON CONTINUOUS WEIGHER.

service. These fail ordinarily through the blades becoming ground down to a thin edge and breaking off. Sometimes a concrete trough along which is dragged a chain of chilled cast-iron links without scrapers, has found favor. This is also good for about a year, and its only advantage is that the frequent renewals are cheap. The ordinary types of scraper conveyor would speedily be reduced to scrap Ashes usually have to be handled red-hot at times which eliminates the belt conveyor from consideration. One or more tubs or ash carts may be operated in a tunnel beneath the boilers, into which the ashes can be raked, and the carts then pushed to the ash pile or to the elevator for discharge in the overhead ash bin. The tubs, of course, are subject to rapid corrosion, but are cheaply repaired. The system involves usually considerable excavation and concrete work, and is thus expensive in first cost.

An automatic skip hoist is very good for elevating ashes, and should be enclosed in a dust-proof casting, preferably of asbestos-cement sheets, which are practically non-corrosive.

A neat little telfer hoist installation was devised by the Dodge Coal Storage Company for the D., L. & W. Railway at Kingsland, N. J. The tubs are lifted from the ash-pit floor by a small telfer operating on 3-phase alternating current, and transferred to a car for disposal. The controlling switch can be placed wherever convenient. The machine has a capacity of 3,000 pounds at 30 feet per minute, and is very effective.

One of the latest and most effectual devices for economically handling ashes in boiler plants, is the suction system recently perfected by the Darley Engineering Company and now in successful operation in a number of plants. A line of heavy 8-inch or 10-inch cast-iron

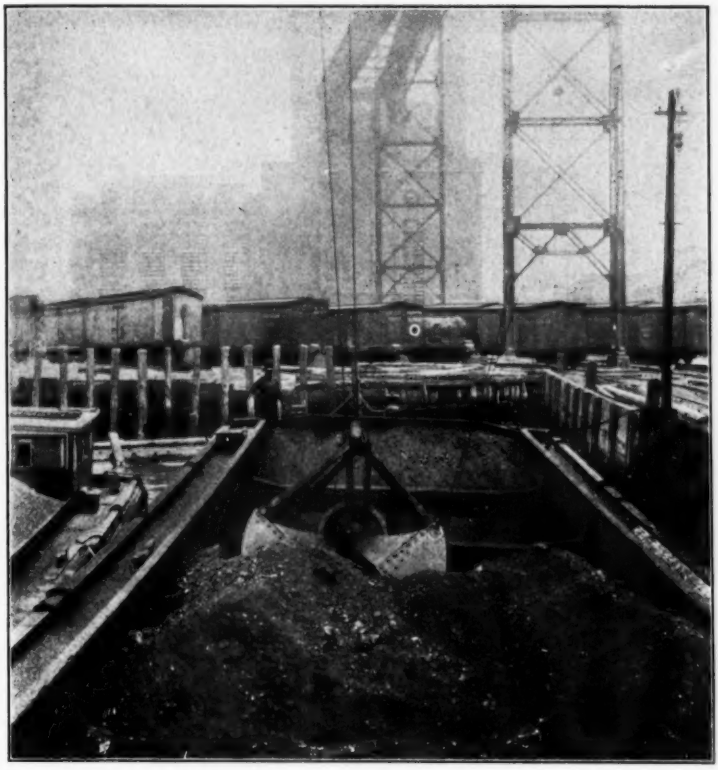


FIG. 29. UNLOADING COAL FROM BARGES BY HAYWARD BUCKET.

pipe extends beneath the ash pits with suction inlets at each. This duct leads directly to the "receiver," an air-tight chamber of concrete or steel lined with cement mortar. Just before entering the receiver a water spray is introduced. Draught is induced by an exhauster fan, direct-connected to an electric motor or steam turbine, maintaining a partial vacuum in the receiver. On uncovering one of the suction inlets, dust, ashes, and clinkers are drawn swiftly through the duct and into the receiver, passing through the water spray which quenches the ashes and prevents the dust mingling with the air drawn through the fan. When the receiver is filled, it is discharged into the storage bin, or if desired, the functions of storage bin and receiver may be combined. Erosion occurs at the bends in the

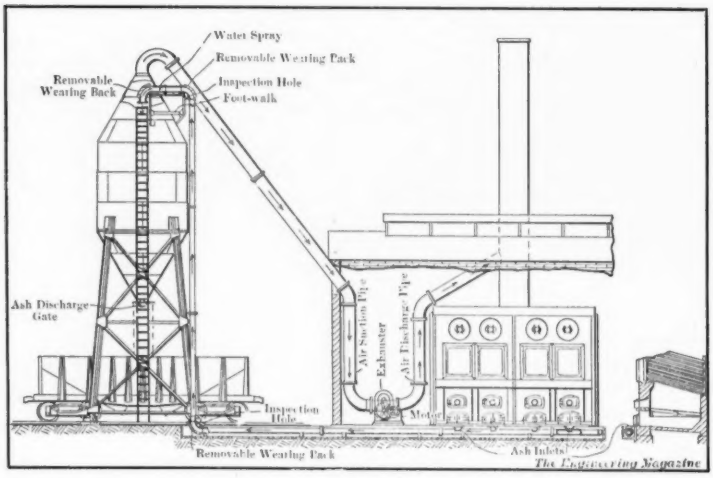


FIG. 30. DARLEY ENGINEERING COMPANY'S SUCTION CONVEYOR SYSTEM FOR ASHES.

duct. These are provided with heavy detachable backs of chilled cast-iron or manganese steel, and require replacement ordinarily at intervals of about 18 months.

The operation of this system is very satisfactory, particularly as regards simplicity and freedom from dust in the boiler room. The suction action is quite powerful, clinkers being handled easily—even brickbats thrown into the ducts are draw up into the receiver under the impulse of the strong induced draught. As generally installed the capacities run up to 16 or 18 tons per hour. Figure 30 is a typical arrangement of the apparatus, the exhaust being shown entering the smoke stack, which may or may not be found convenient.

BAMBOO COTTAGE, CENTER OF JAMAICA MINING DISTRICT.
Congo Hill mine is 1 mile east and Elmo mine 3 miles west of this point.

THE COPPER MINES OF JAMAICA, BRITISH WEST INDIES.

By Alexander E. Outerbridge, Jr.

Mr. Outerbridge's short description of the Jamaica copper region is based on personal observation supplemented by private sources of information, and is presented for its interest in giving a general but graphic idea of a district as yet little known.—THE EDITORS.

THE island of Jamaica is one of the most fertile regions of the world. The luxuriance of the tropical foliage and the salubrious climate, during eight or nine months of the year, combined with the picturesqueness of the mountain scenery, made it a well-known winter resort long before the great earthquake, which partly destroyed the capital, Kingston, on January 14, 1907. Since that time the trend of tourist travel has been largely diverted.

It is now generally conceded that the so-called earthquake of 1907 was, in reality, merely a local landslip; the fear of a recurrence of such a disastrous visitation is passing away and visitors in search of health and recreation are again venturing to the island.

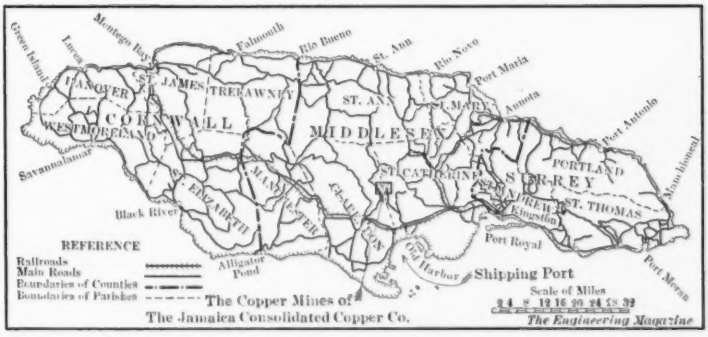
In March last I was a member of a party of Americans who went to Jamaica mainly for the purpose of ascending the famous Blue Mountain Peak, the highest mountain in Jamaica, 7,443 feet above the sea, according to topographical survey. The ascent was successfully made on horseback after strenuous riding up and down steep trails during two delightful days. One night was passed at a bungalow on a coffee plantation more than half-way up the mountain.

During this visit to Jamaica my attention was called to some recent explorations, mainly in the Clarendon Hills, exposing vast deposits of copper silicates, (chrysocolla) copper pyrites, (chalcopyrite) red oxide, (cuprite) bornite, blue and green carbonates, copper glance,

TWO BITS OF PANORAMA IN THE JAMAICA COPPER REGION.
The Clarissa mine is at the extreme left and the Copperwood a little to right of center of the lower picture.

and other copper ores, carrying silver, gold and other metals. Some interesting specimens of these ores were obtained for the cabinets of minerals of scientific bodies with which I am associated.

The existence of copper ores in Jamaica was evidently known to the Spaniards several centuries ago, as the name of one of the large rivers "Rio Cobre" (Copper River) indicates. When the English took possession of the island in the seventeenth century they devoted their attention to agricultural pursuits which at that time yielded immense profits. It is of record, however, that in the year 1854 samples of copper ore were sent from the island to the Revere Copper Mining Company, of Boston, and smelted, producing about 24 per cent metallic copper.



SKETCH MAP OF THE ISLAND OF JAMAICA, SHOWING LOCATION OF COPPER DEPOSITS.

In 1869 there was published, by order of the Lord's Commissioners of Her Majesty's Treasury in London, a valuable report on the "Geology of Jamaica," by James G. Sawkins, F. G. S., in which the copper deposits are thus described:

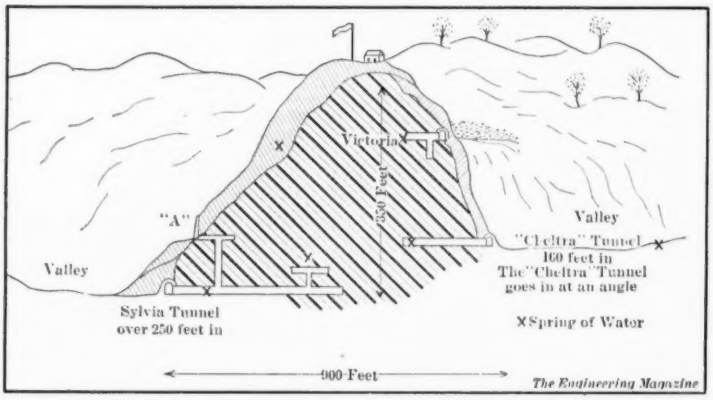
The Clarendon mines afford a nearer approach to true lodes of mineral veins than any of the other metalliferous deposits of Jamaica. Without being contained in mechanical fissures, still the deposits are bound by definite walls and characterized by distinct gangue and ribs of ore. These ribs of ore are easily separated from the intervening gangue and when so separated showed analysis of copper 33 to 37 per cent.

It would seem natural that a report of such character, emanating from a reliable source and evidently free from ulterior motive, would have promptly called attention to the undeveloped mineral wealth of Jamaica, especially in the Clarendon hill region, of these copper-ore deposits; but, so far as I can ascertain nothing further was done until 1902, when Professor Wm. P. Thorney, of Baltimore, examined the copper outcroppings in the Clarendon hills, making ten openings which showed the presence of copper ores.

On the strength of these reports, and especially the favorable results of a number of analyses (made by Prof. Thorney, Messrs. Ledoux & Company, metallurgists and assayers, New York, the Ogden Assay Co., Denver, Colorado, the chemists of the Department of Agriculture, Kingston, Jamaica, and others) a number of Boston men obtained a lease, in 1906, of no less than 2,276¾ acres of land in the Clarendon hills—nearly 4 square miles—with option of purchase within a few years, and since then have been spending their own capital prospecting and tunneling into these hills. Rapid progress has been made, as will be seen from the brief statements obtained from Mr. J. H. Mac Nish of Kingston, Jamaica, who has resided in the island

about 20 years and is largely identified with these recent copper developments that give promise of great economic value and importance to Jamaica in an entirely new and hitherto undeveloped field.

At the time of my visit to Jamaica there were about seventy-five laborers at work blasting out ore, and sixty-two openings had been made. "From more than forty of these openings different kinds of ore have been taken showing profitable copper values, all carrying more or less value in silver and gold."



SKETCH OF MINES, JAMAICA CONSOLIDATED COPPER COMPANY.

The climate is such that work can be carried on day and night the entire year. More than 1,200 feet of tunnels had been made up to March last. The mining will be done entirely by tunneling; no pumping of water or hoisting of ore will be necessary, hence it is claimed to be the cheapest mining in the world, except, perhaps the iron-ore mining at Pilley's Isle, Newfoundland, which is unique in this respect.

A peculiar feature of this proposition is that a great portion of the estate is under cultivation, furnishing a large revenue, besides all the food stuffs required to feed all the hands now, or that may be in the future, employed on the plantation or in the mines. The remainder is mainly forest land containing all the timber that could ever be used in the mines or in the erection of buildings, and also precious woods of various kinds.

Native labor is employed with success, at an average of 37 cents per day; this is more than is paid agricultural labor in the fields on the neighboring plantations.

There is no railroad running directly to the mines at present; the nearest railway station is but 12 miles distant over roads so perfect as

THREE MINES IN THE JAMAICA COPPER DEPOSITS.

On the left, the Cheltra, west side of Victoria Hill; on the right, the Sylvia No. 1 (below) and Sylvia No. 2 (above), east side of Victoria Hill.

to be equalled only by the finest park roads in the United States. I was, indeed, astonished at the magnificent roads throughout the island, even in the mountainous districts. These roads were originally constructed for military purposes by the British Government, and since the withdrawal of the army to a very large extent, the native Government has wisely appropriated sufficient funds annually to keep all the roads in fine order. Several friends made extensive automobile journeys in a touring car, which they took with them, and all were enthusiastic on the subject of the good roads in Jamaica.

The shipping port for the ores from the properties of the Jamaica Consolidated Copper Company will be Old Harbor Bay, about fourteen miles from the mine, and it is estimated that the expenses including freight to the New York smelter will not exceed $3.50 per ton. The management calculate on shipping over a hundred tons a day of ore.

Since my return from Jamaica I have received several letters from Mr. Mac Nish giving later information regarding the progress of the work, from which the following data are obtained. "The company is now closing its option for the purchase of the entire property of 2,276¾ acres including 240 acres of hard wood lands, and deeds are being prepared." "There are now 11 mines opened ¼ to 4 miles

THE 20-FOOT VICTORIA VEIN.

ANOTHER VIEW OF THE VICTORIA VEIN, 20 FEET WIDE.

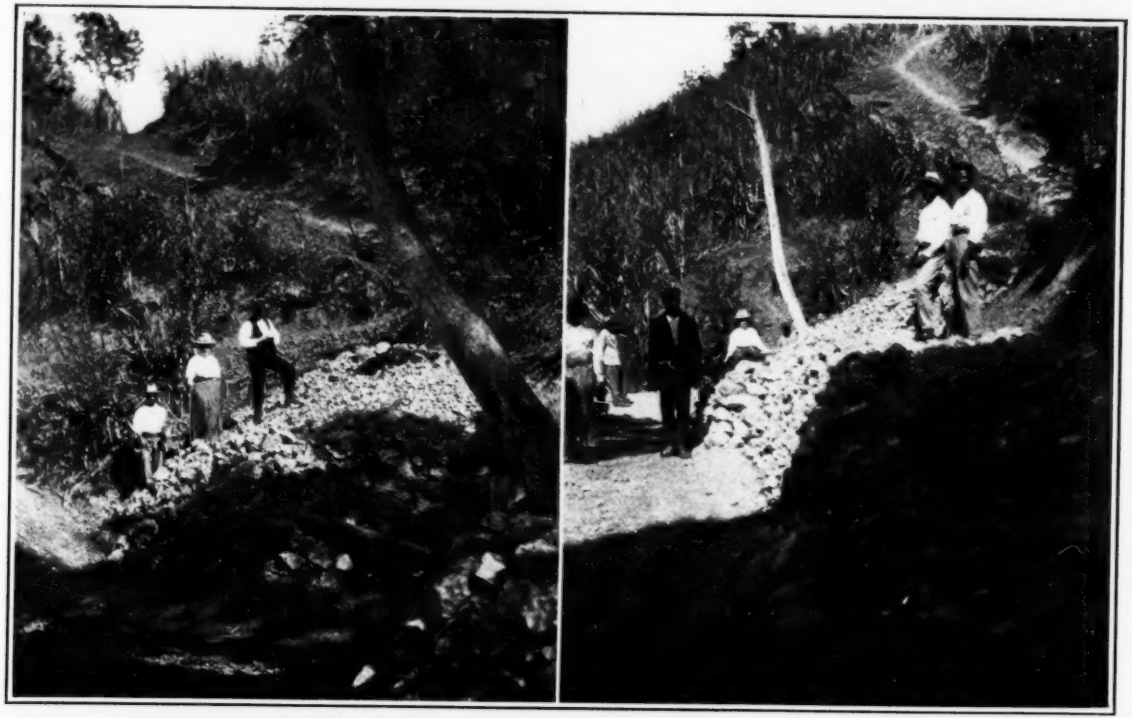
apart." "110 men at work (night and day) 3 shifts." "Tunnels, drifts, etc., done to date (April 27) in 28-months' work more than 3,000 feet. Veins have been followed of true fissure nature."

Under date May 10th, Mr. Mac Nish writes "the vein in the Victoria hill is 26 feet and not yet through; this is 350 feet below the top of the hill and 250 feet in the tunnel. There is no doubt this vein goes clear through the hill; it is only one of eleven mines now open."

After making careful search in various "Indexes of periodical literature" as well as in those of technical magazines, for ten years past, I have been unable to find any description of the copper deposits of Jamaica, and I believe therefore that the brief account here given is the first to call attention to the matter in any periodical.

The well known "Copper Handbook" of Stevens, issued annually, has the following meagre notice which has long remained unchanged:

JAMAICA. There is a cupriferous district near the middle of the island, on which a little exploratory work was done, and from which one small shipment of ore was made, circa 1854. Since that date there have been repeated efforts to organize mining companies, and develop mines, but no permanent results have been secured. Apparently the deposits first opened were of small extent and of low value. There are indications of copper and other metals at various other points in the island.—*The Copper Handbook*, Vol. 18, p. 224—1908.



ORE DUMPS AT THE VICTORIA MINE.
No. 2 on the left; No. 1, 80 feet long, on the right. Sugar cane is growing on the hillside.

AT THE VICTORIA MINE OF THE JAMAICA CONSOLIDATED COPPER COMPANY.

The upper view shows the 20-foot vein from the outside; the lower is taken within the tunnel, looking toward the light. On the hill opposite is an outcropping of ore like that of the Victoria.

ASSAYS OF JAMAICA COPPER ORES.

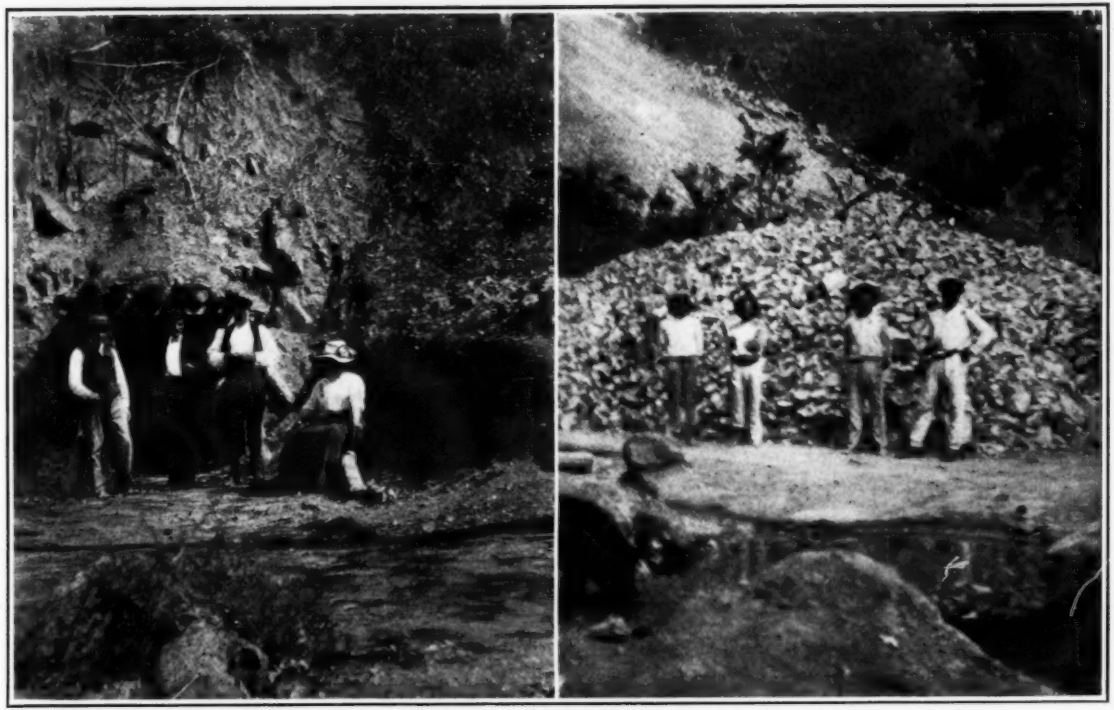
Date.	Mark.	Gold. ounces.	Silver. ounces.	Copper. per cent.
Ogden Assay Co., Denver, Colo.				
May 14, 1907	.....	0.04	Trace	4.06
May 31, 1907	.....	0.05	4.04	11.09
June 4, 1907	.....	0.10	1.20	30.35
June 17, 1907	.....	0.06	0.60	28.53
June 24, 1907	.....	0.06	0.80	4.22
June 26, 1907	.....	0.04	2.72	10.82
June 28, 1907	.....	0.08	15.20	32.55
July 9, 1907	.....	0.08	2.60	35.59
July 20, 1907	.....	0.05	19.70	44.01
Aug. 12, 1907	.....	0.10	11.20	16.64
	.....	0.06	1.80	26.67
	.....	0.02	0.60	10.80
	.....	0.04	1.40	27.30
Aug. 17, 1907	.....	0.05	0.70	16.70
	.....	0.05	0.60	11.82
Feb. 17, 1908	.....	0.24	5.48	12.15
Mar. 10, 1908	.....	0.05	8.00	15.41
June 30, 1908	.....	0.17	2.40	20.52
July 11, 1908	.....	0.05	0.60	43.72
July 27, 1908	.....	0.06	2.04	19.20
Oct. 20, 1908	.....	Trace	Trace	45.42
Oct. 21, 1908	.....	None	Trace	69.32
Dec. 15, 1908	.....	1.72	56.44	16.63
Jan. 3, 1909	.....	0.05	6.30	24.51
Agricultural Chemist's Laboratory, Kingston, Jamaica.				
Dec. 7, 1906	No. 1	....	....	43.18
	No. 2	....	....	20.45
Dec. 10, 1906	.....	....	....	68.10
Feb. 27, 1907	No. 1	....	....	25.7
	No 2	....	....	9.4
	No. 3	....	....	5.4
Sept. 11, 1908	Victoria No 1	....	....	32.25
	Elma	....	....	40.00
	Congo Hill	....	..	4.25
	Victoria No. 2	....	....	15.00
	Iva	....	....	11.75
Robert S. Edwards, Boston, Mass.				
Oct. 1, 1908	Victoria	....	....	16.10
Oct. 8, 1908	Victoria	....	....	36.22
Arthur C. Claudet, London.				
July 26, 1907	.....	0.3	40.55	22.60
Ledoux & Co., New York.				
July 12, 1906	I. A.	0.07	34.70	24.55
Edward E. Bugbee, Boston, Mass.				
	Clarissa	....	....	21.03
	Congo Hill	....	....	4.09
	Cyril	....	....	11.47
	Iva Mine	....	....	18.45
	Elma	....	....	7.15
	Sylvia	....	. ..	10.05
	Victoria Tunnel	....	....	13.68
	Victoria Shaft	.....	....	16.05

With regard to the prospective commercial value of the Jamaica copper mines I do not attempt to express an authoritative opinion. While in Kingston I met a well-known merchant and planter, Mr. Daniel Finzi, who exhibited quite a number of samples of copper ores which he had collected on one of his plantations and he stated that he was on his way to England with the view of obtaining capital for development. The samples were similar to those described in this paper. He showed several analyses made in New York and elsewhere yielding on an average about 24 per cent copper. No metallic copper has been found so far as I can ascertain.*

SPRING 2,000 FEET ABOVE SEA LEVEL, NEVER KNOWN TO GO DRY.

The fact that most of the veins are situated on the hillsides not far from the coast, that the roads are superb, that the railroad is within ten or twelve miles, that the climate is salubrious, that labor is cheap and abundant, that wood is plentiful, and that the land is under a high state of cultivation, all seem to be favorable factors from a commercial standpoint.

* A letter received June 7 states "A few pieces of metallic copper have recently been found with traces of carbonate on edges." Another letter, arriving just as these pages are made up, says that ore from the Cyril tunnel "has red oxide and lots of metallic copper."



THE IVA MINE TUNNEL, AND THE ORE DUMP AT CONGO HILL MINE.

The Iva tunnel is 9,000 ft. from Victoria mine, and is in a 9-foot vein of rich ore (bornite); the Congo Hill tunnel is in 500 ft., with three veins of copper pyrites ore, 1½ miles from the Victoria mine.

In view of the foregoing considerations it seems reasonable to expect, as a result of the extensive exploitation now going on in the Clarendon hills, that an entirely new industry of considerable economic importance to the island of Jamaica will be developed in the near future.

The illustrations accompanying this article were all taken during the past few months.

Appended hereto will be found in tabular form a number of assays, made by various well-known chemists, of samples of copper ores taken from numerous openings in the Clarendon hills comprised within the four square miles of property controlled by the Jamaica Consolidated Copper Company. Also a letter from the Curator of the Academy of Natural Sciences giving a complete mineralogical classification of a number of samples of copper ores from different mines in the Clarendon district.

A similar letter has been received from the Franklin Institute acknowledging a donation of duplicate specimens.

ACADEMY OF NATURAL SCIENCES, LOGAN SQUARE,

Philadelphia, June 2, 1909,

My dear Mr. Outerbridge:

Dr. A. P. Brown of the University of Pennsylvania examined the specimens of copper ore today. He says the bulk of the ore is Chalcocite (Sulphide of Copper) and Bornite (another Sulphide of Copper) with Chrysocolla, Malachite and Azurite which make the green and blue incrustations. There are some specimens of Cuprite (Red Oxide of Copper), there are small spots or crusts of some other material, Garnerite (Silicate of Nickel and Magnesium) and Mohawkite, which is the material referred to as "Metallic Copper" on one of the labels; it is really a nickel-ore.

Dr. Brown says the samples from Sylvia Mine and the Victoria Mine (namely Chalcocite) are very rich ores.

I shall have his labels copied and placed with the specimens, retaining some samples for the Academy.

Sincerely yours,

(Signed) WITMER STONE, Curator.

DR. A. P. BROWN'S CLASSIFICATION OF SPECIMENS.

No. 1. Bornite with Azurite and Malachite. From Iva Mine.

No. 2. Chalcocite with Malachite and Chrysocolla (very rich ore). From Victoria mine.

No. 3. Chrysocolla and Chalcocite (rich ore). From Sylvia mine.

No. 4. Bornite and Malachite with Chalcocite and Chrysocolla. From Clarissa mine.

No. 5. Metallic mineral, Dorneykite or Mohawkite. Red, Cuprite. From Sylvia vein.

No. 6. Chalcocite and Chrysocolla. From Elma mine.

No. 7. Red, Cuprite. Blue green, Chryscocolla. Bright green, Garneirite. Tarnished patches, Mohawkite. From Sylvia mine.

MATERIALS AND METHODS OF CONSTRUCTION FOR INDUSTRIAL BUILDINGS.

By J. P. H. Perry.

WITH SPECIAL REFERENCE TO THE COMPARATIVE COST OF REINFORCED CONCRETE AND MILL CONSTRUCTION.

AFTER deciding that an additional building or that reconstruction is necessary, the industrial executive is confronted with a choice of materials and methods of construction. He wants the best possible building at the least possible cost. By least possible cost is generally meant not only the initial cost, but also ultimate cost, which takes into consideration interest, maintenance, depreciation, and insurance charges. In most instances there are other yearly expenditures (such as amount of power required to operate the machinery used in the manufacturing processes, the repairs on the machinery, vermin losses to stock and to finished products, amount of light available, and the sanitary conditions as they affect the efficiency of the employees) entering into the relative costs of different kinds of industrial buildings.

In general there are two classes of structures from which the selection is to be made—non-fireproof and fireproof.

The various types of the former are legion and will not be considered in detail herein, as it is assumed that except in connection with special industries, which constitute but a very small percentage of the commercial interests of the country, non-fireproof structures are neither suitable nor economical and do not attract serious attention on the part of the progressive business man. Despite the low initial cost of non-fireproof construction, in many cases it is possible to show that a more expensive fireproof building will afford the better investment for capital when the items of yearly expenses as noted above are considered.

The second class of industrial structure, however, naturally divides itself into three distinct and separate types—structural steel, mill construction, and reinforced concrete. Before going into the comparative merits and costs of these three varieties of buildings it will be well to make clear what is meant by the term fireproof.

The method of construction which will result in a fireproof building is simple in conception and theory, and, though of wide range in its applications and workings out, is not difficult of comprehension by the layman. A stove is fireproof—only its contents burn. A fireproof building must be similar to a stove as far as its own properties are concerned. With respect to its contents it must be like a battery of coke ovens—so arranged that any one fire can be confined to its starting point. The fundamental idea in fireproof-building design is to restrict the possible fire to as small an area as is practicable, and having done this, to provide means for quickly extinguishing the blaze. In order to carry out this basic principle it is necessary to have walls, floors, and partitions constructed of non-combustible materials, the windows either set with metal frames and glazed with wire glass or else protected by metal shutters, and to have all doorways fitted with metal-covered wood doors closing automatically by means of fusible-link connections. In addition, the building should be laid out with provision for numerous fire walls. All stair and elevator wells must be enclosed in fire-resistant partitions. Given a stove-like building such as would be obtained by following these specifications, it is further imperative to install apparatus capable of putting out a fire as soon as it starts and at the same time giving alarm to the local fire-fighting forces—be they maintained by the city or town or a part of the factory staff. Automatic-sprinkler systems equipped with pressure tanks and connected with ample water supply, as well as numerous hose lines and hydrants when inspected and repaired at proper intervals, will, together with automatic fire alarms, provide the protection which the owner of a well constructed fireproof building has a right to demand.

Regarding this question of fireproofness, it may not be amiss to emphasize the great importance of carrying out the details completely. So often it occurs that a building is put up of non-combustible materials and that is all. Its owner believes his structure to be fireproof in every way, whereas it offers no adequate protection to its contents. A fire in a neighboring factory might spread through its wooden and plain glass windows, and once obtaining a foothold go from one end of the building to the other. To be sure, the fire-resistant frame and walls would be serviceable soon after the fire, but when the comparatively slight expense of installing fireproof details in accordance with the rules of the National Board of Fire Underwriters is considered it is a pity to lose 50 per cent of the fireproof value of the structure. To bring out this idea more forcibly reference can properly be made to the Iroquois Theatre disaster in Chicago in December, 1903. The details of the loss of life in that holocaust are familiar to everyone.

And yet that theatre two days after the fire was in as good condition as the day it was turned over to the painters and decorators to put on the finishing touches. It was a matter of but small expense to put the building in condition for its opening soon afterward as the Northwestern Theatre. The tremendous loss of life was attributable to the unusual carelessness with which a few details of exits, smoke vents, and curtains were executed or neglected. The building was fireproof in itself, only the managers failed to carry to completion the fundamental conditions necessary to the confining or the controlling of a fire once it got under way.

As previously stated, fireproof construction may be obtained by the use of any one of the three following structural methods: structural steel, reinforced concrete, and mill construction.

Structural steel, in order to be included in this class of building, must be thoroughly protected with some form of fireproofing such as brick, terra-cotta block, or concrete. With careful design and faithful execution an industrial building of steel can be erected which will meet perfectly fireproof requirements and procure the approval of the Board of Fire Underwriters. It will obtain minimum insurance rates, will be low in maintenance and depreciation charges, and, in addition, will admit of very quick erection when that is important. Vital question as it is, however, the proper fireproofing of structural steel frequently fails to receive the attention it requires. Very common is the idea that steel is so good that it can take care of itself. In the San Francisco and Baltimore conflagrations there occurred many cases where the collapse of a building was due to the failure of the fireproof (?) protection around the steel columns. Numerous instances are on record where terra-cotta and plaster-on-metal-lath coverings subjected to hot fires gave way, and the flames reaching the steel columns caused them to buckle and pull the building down. In spite of these dangers there is no question about the excellency of fire-class steel construction. Every day buildings of steel are being put up which are fireproof in the highest sense of the term. The only serious argument against steel is its cost. The fireproofing of every structural member with a second material increases the cost of erection considerably—so much so, indeed, that reinforced-concrete contractors can and have in many citable cases underbid the structural-steel men when figures were being taken on plans which called for a first-class fireproof structure put up in either concrete or steel. Reference to an actual building will establish this statement. In May, 1908, the contracts were let for a department-store warehouse in Brooklyn having about six acres of floor space under one roof, and constituting a large and in every way com-

plete fireproof propositon. At that time the building market in New York was at a low ebb and all contractors were hungry for work and were willing to accept jobs on very nearly cost basis. Alternate figures were taken by the owners' architect on reinforced concrete and steel. The successful concrete bid was $30,000 under the lowest steel figure—representing a saving for concrete over steel of about 12 per cent. In another instance on a publishing plant and general office building of very large size in Springfield, Mass., the successful reinforced-concrete bid was about $40,000 lower than the steel estimates —a saving of approximately 10 per cent.

In buildings where long spans—such as those in excess of fifty feet —are necessary, steel, owing to its lightness in truss form, has the advantage over any other material. Furthermore, where small loads are to be supported it is often possible to design a building in steel and keep the cost under that of a satisfactory design in reinforced concrete or any other fireproof material. For one-story factories of large ground area structural steel is an ideal material, but for the normal type of industrial building, where the question of protection against fire is of importance and where the building is several stories high with loads of 150 pounds per square foot or larger, structural steel where properly fireproofed will be found to exceed in cost the same structure erected in concrete. The question of the relative merits of the two materials as regards fireproofness, vibration, and maintenance admits of long discussion and will be omitted here as only the cost item is to be taken up. It may be conservatively stated, however, that concrete gives as good service along these lines as any other structural material, if not better.

The factory or mill owner after considering structural steel for his proposed building has—if a fireproof structure be in his mind—either reinforced concrete or mill construction to choose from.

By reinforced concrete is meant a building having a concrete framework or skeleton and either concrete, masory, or brick curtain walls. The concrete frame must have steel reinforcement designed, fabricated, and placed by or under the supervision of technically trained and experienced engineers. Too frequently is the assumption made that concrete is an easy thing to handle and that any one can work with it safely. The collapses and failures of concrete structures which have occurred in the United States have been due to just such ideas. The plans for the buildings have been drawn by men who did not appreciate the amount of detail and the study necessary to provide for all contingencies. The erection was intrusted to contractors who had no perception of the importance of the proper placing of the rein-

forcement nor of the necessity of rigid inspection of materials constituting the concrete, let alone an appreciation of the problem of forms and their removal. Granted that reinforced concrete is given the consideration every other structural material receives as far as design and erection are concerned, there is presented to the prospective builder or owner a material and method of construction which though comparatively new commercially (but old historically) is entirely satisfactory for industrial purposes. Reinforced concrete is being used all over the world today for nearly every kind of structure, from telegraph poles and fences to great arch bridges, sixteen-story buildings, and factory plants many acres in extent. Its properties with respect to the comparative costs with other materials are in the main its most interesting feature and will be discussed in detail in this article. Before taking up the various items entering into this subject a definition of what is meant by mill construction is necessary.

"Mill construction" is a term applied to a certain type of mill and factory construction developed and utilized most widely throughout New England—especially, however, in Massachusetts. Its detail growth was fostered by the Mutual Fire Insurance Companies and by insurance interests generally, with the object of reducing the fire losses among the great manufacturing plants of that territory. As a result of many years of investigation, experiment, and study, a method of putting together more or less non-fire-resistant materials to form a semi-fireproof or so called "slow-burning" building has been arrived at and adopted very successfully throughout this country. Primarily mill construction is based upon the use of yellow pine or oak timbers of large size and close spacing, the controlling idea being to take advantage of the inability of fire to eat its way into wood in large bulk. Experience has shown that an ordinary fire will not burn a 12-inch by 12-inch wooden column for a depth greater than an inch or two and that a 4-inch wooden floor supported on heavy joists is equally slow to burn up. By lavish use of heavy timber it is possible, with the assistance of sprinklers, automatic fire doors, and every Underwriter's detail, to build a factory which will be slow-burning and consequently more or less fireproof.

This mill construction offered a method of building which possessed many of the advantages of steel and yet was cheap enough to bring it within the range of many owners who could not put up a first-class steel building. By careful adherence to details of design, installation of firewalls, etc., fire losses were reduced to a low point with a natural lowering of insurance rates, which was the great desideratum.

The question of which is the better—reinforced concrete or mill construction—admits of close study before a satisfactory answer can be obtained. The decision between the two construction methods would seem to depend largely upon which will show itself for a term of years to be the best investment for capital—all things considered. If it is possible to demonstrate an annual saving for one type of building over the other, the superiority of that class of structure should be firmly established.

In comparing reinforced-concrete buildings with slow-burning mill construction there are several factors which must be considered in detail as follows:

ITEM I. INITIAL COST. Under normal conditions the first cost of a reinforced-concrete building will vary from an excess of 10 per cent down to figures equal to these obtainable for mill construction. This variation is inversly proportional to the size of the building. The larger the structure, the more nearly equal become the bids of the two classes. There have been instances, notably in Minneapolis and Toledo, where in connection with very large warehouses—exceeding a quarter of a million dollars in cost—estimates on mill construction exceeded those for reinforced concrete and the latter material was adopted. In the medium-sized warehouse, mill, or factory—buildings costing from $25,000 up to $100,000—the mill-construction building will cost less than concrete by about 5 per cent or 10 per cent. By citing actual cases this statement can be made more clear. For a grocery warehouse in Jersey City the contract price for the concrete building was $3,900 higher than the best mill-construction bid—this on a building costing approximately $40,000. In another case, on a small flour warehouse on Manhattan Island the concrete bid was $15,000 against $13,500 for mill construction—a difference of 11 per cent. Actual bids were submitted for a paint factory in Brooklyn at a total cost of about $75,000 where the bid of the reinforced-concrete contractor was a few dollars below the bid of the mill-construction man. In this case the specifications of the Board of Fire Underwriters for a first-class mill-construction building were lived up to in every detail. It will be conservative, therefore, to assume for purposes of ultimate comparison that concrete will run over mill construction 10 per cent in first cost.

ITEM II. YEARLY COST OF INSURANCE. Though reinforced concrete has not received the support from the fire-insurance interests that it should and in some localities has had a hard fight to obtain its just dues, it is gradually becoming recognized by the Underwriters as being a good friend of theirs and one to be encouraged by means of reasonable rates. The vice president of the Boston Manufacturers'

Mutual Fire Insurance Co., Mr. L. H. Kunhardt, has published a valuable table of rates on different classes of buildings. The data are taken from typical examples throughout the United States. The table is based upon absence of automatic sprinklers and other private fire-protective appliances of the usual completely equipped building. They are not schedule rates, but may be an approximation to actual costs under favorable conditions based on examples in various parts of the country.

CONCRETE FACTORIES VS. THOSE OF WOOD OR BRICK.

Approximate Yearly Cost of Insurance in Cents per $100.
Exposures, none; area not large; good city department; no private fire apparatus except such as pails and standpipes.

	All Concrete.		Brick Mill Construction or Open Joists.		Wood Mill Construction or Open Joists.		Add for Brick or Wood Bldgs. in Small Towns and Cities without best of Water and Fire Departments.
	Bldg.	Contents.	Bldg.	Contents.	Bldg.	Contents.	
	All figures are in cents.						
General Storehouse	20	45	60	100	100	125	25
Wool Storehouse	20	35	40	60	75	100	25
Office Building	15	30	35	50	100	125	25
Cotton Factory	40	100	100	200	200	300	50
Tannery	20	40	75	100	100	100	25
Shoe Factory	25	80	75	100	150	200	50
Woolen Mill	30	80	75	100	150	200	50
Machine Shop	15	25	50	50	100	100	25
General Mercantile Bldg.	35	75	50	100	100	150	25

Supplementary to these theoretical insurance rates it will be interesting to cite some actual rates written for concrete buildings in the Metropolitan District of New York City. On a paper-goods factory covering one acre of ground and nine stories high, constructed of reinforced concrete throughout, the rates are below. The rate given for the mill construction applies on another factory of the same company having about three acres of floor space and under the same conditions as the concrete building with respect to ownership, exposure hazards, occupancy, contents, and automatic protection.

	Building.	Contents.
	cents per $100.	
Concrete Factory	12.6	29.4
Mill-Construction Factory	21.5	63.5

On other concrete industrial buildings which are known to me the rates obtained are: On a large color-works plant on Staten Island—complete in itself—having offices, factory, power plant, etc., the rate on building and contents is 10 per cent. On three very large model

factory buildings in South Brooklyn the rates on the building are 12 cents; contents, 18 cents. On an eight-story loft building in the shopping district of New York the concrete structure obtains a rate of 10 cents; contents, 18 cents.

ITEM III. DEPRECIATION. Owing to the changing conditions of American life and the comparatively short duration of the average business, exact data on depreciation are difficult to obtain. Kidder's Handbook gives the annual depreciation of a mill building as varying from 1 per cent to 1½ per cent; or, in other words, the life of the building as about 66 years. These figures include roofing, doors, windows, and other details.

The amount of depreciation on a concrete industrial building would be confined almost wholly to roofing, doors, and similar parts of the structure not of concrete. Though theer are no records on which to base the estimate other than a knowledge of the permanency and constantly increasing strength of the material as well as the protection it affords the reinforcement, it may be conservatively stated that under the same conditions as given above for the mill building the annual charge for a sinking fund on a reinforced concrete factory or mill or warehouse would not exceed one-half of 1 per cent (0.5 per cent).

ITEM IV. RESULTS OF VIBRATION. For warehouses, foundries, and similarly used buildings the vibration element does not enter. In the ordinary industrial structure, however, one of the most important factors in a successful plant is the keeping down of machinery repair charges. Vibration in the building plays a considerable part in the size of these charges. If machines placed in position will remain so and if shafting once lined up will not vary, the repairs to machinery, and more particularly the cost of operating the machinery, will be at a minimum. Vibration in the building causes "walking" with consequent getting out of level or off center and increased wear on journal blocks and moving parts, and an increase in the amount of power necessary for operation.

Concrete buildings have been chosen in several instances because they practically eliminated vibration. There are many buildings of this material in which heavy machinery is operated on upper floors without any indication of their presence being given in the lower stories. A prominent paper-goods manufacturer in Brooklyn, N. Y., the owner of both reinforced-concrete factories and slow-burning mill-construction buildings, has stated that his concrete structure saves $5,000 a year in machinery repair and operation charges. This amounts probably to ½ per cent on the value of the building. On plants where the amount of machinery installed was not as large as in this instance the

percentage saved based on the value of the building and contents would be less. It may be assumed, however, for purposes of comparison, that in the ordinary manufacturing concern the saving in the items under discussion by the elimination of vibration would amount to $450 per year or $1.50 per day. When it is remembered that this includes power, oil, attendance, new bearings, parts, belts, and wear on the building besides, the estimate is probably low. The increased efficiency of the machines alone would in most cases equal this daily saving.

ITEM V. LIGHT AND SANITARY CONDITIONS. In discussing the building of a new concrete garage recently the owner said that he found that his men could repair an automobile when it was standing out of doors in nearly one-half the time they could when it was in his present old wooden structure; he therefore insisted on having maximum light in his prospective structure. The effect upon the efficiency of employees of the amount of light obtainable is sometimes not appreciated by owners. Assume that a plant is running with 100 operatives. If the window area should be increased 20 per cent, would not each employee increase his efficiency at least 1 per cent? This would be brought about not only by their being able to see better, but, also, by the raising of their spirits owing to more cheerful working conditions. In most instances the increase in earning power of the working force would be higher than the assumed figure.

The surroundings in which a man labors are being recognized as having a decided bearing on his output. Clean, sanitary rooms, with plenty of light, good ventilation, and uniform temperature, have a certain dollar-and-cents value. A saving of one per cent per day per employee, with 100 hands, represents $300 per year, and one cent a day for a man earning from $2 to $4 requires but a small increase in his effectiveness.

Reinforced-concrete buildings, owing to the method of erection used, permit having maximum light. It is not unusual to find buildings of this material with 70 per cent of their wall space taken up by windows. It is possible to increase this light area to 80 per cent when necessary. With mill construction as generally adopted the window area does not run over 30 or 40 per cent of the wall.

Cement being a lime product is essentially sanitary. The waterproof properties of reinforced-concrete construction render frequent washing of floors possible and make dampness or rotting impossible where wet processes are involved. The low conductivity value of concrete results in small variation in temperature within the building and the homogeneous construction largely prevents draughts.

With these facts, not theories, as a basis, the assumption that the effectiveness of the employees will be increased at least 1 per cent by using reinforced concrete in place of mill construction is conservative.

ITEM VI. VERMIN LOSSES. Vermin cause loss to most lines of industry. Either raw materials or finished products are subject to the inroads of mice, rats, or bugs, and though in well run plants the damage may be slight, what there is has a money value. As an example of this the experience of one manufacturer may be cited. With two mill buildings and one reinforced concrete factory for purposes of comparison, he states that the last-named structure saves him $4,000 per year in vermin losses alone. There is no place in a concrete building for rodents to live. If they do come in with packing cases they either go into neighboring quarters or are easily caught. It will be fair to assume that for the ordinary business vermin are responsible for $100 loss annually.

ITEM VII. PROTECTION FROM FIRE. Although the owner has his building and contents fully covered by insurance, he cannot protect himself against losses by fire, losses to his reputation owing to his failure to complete orders or contracts, to the efficiency of his organization owing to the acceptance by skilled operatives of other jobs during the shut-down of his plant, and to his trade because of inability to accept new business until he can find a new building. A small fire does about the same amount of harm to any kind of building, except that with wooden floors water damage is higher than fire damage—with concrete buildings the water is confined to the floor where the fire occurs. With a serious fire or a conflagration the destruction of the average building is assured. On this one point alone reinforced concrete often is of tremendous value to the manufacturer. The certainty that fire cannot destroy his building is of importance. Concrete first attracted attention because of its absolute fireproofness. Factories of concrete cannot burn up. Their contents may be ruined but the structure itself is ready for occupancy as soon as it is cool.

"Use and Occupancy" insurance policies cost about ½ of 1 per cent. They cover estimated profits, commissions, or similar legitimate sources of income based upon the use and occupancy of a given manufacturing plant. In event of fire causing interruption of the business, the insurance company will pay the insured a certain amount for each day the building is out of commission. The value of a non-destructible building ought to be at least as much as this "Use and Occupancy" insurance, for not only would such a structure protect the owner to a certain extent against loss of profits, but, as well, against injury to reputation and organization as above noted. Assume, therefore, that re-

inforced concrete buildings will save ½ of 1 per cent per year owing to the protection which they give against destruction by fire.

ITEM VIII. INCREASED TAXES, INSURANCE AND INTEREST CHARGES OWING TO INCREASED COST OF BUILDING. The taxes on either a mill-construction or a concrete building would be at the same rate. The interest charges on the original investment and the insurance on the building should also be considered.

The following tabulation sums up the various comparisons just made between reinforced-concrete and mill construction. Assume a building costing complete $100,000; contents equal to the cost of the building; and that it is used for general manufacturing purposes.

	Mill Construction. Yearly Charges.		Reinforced Concrete. Yearly Charges.
Initial Cost of Building	$100,000		$110,000
Interest at 6 per cent	$6,000		$6,600
Taxes at 1 per cent	1,000		1,100
Insurance on Bldg. at 75 cents per $100 value	750	at 25 cents	275
Insurance on Contents at $1.00	1,000	at 80 cents	800
Depreciation on Bldg. at 1¼ per cent	1,250	at ½ per cent	550
Results of Vibration. Assume $450.	450	Chargeable against mill bldg. only.	
Increased Light—1 per cent increase in efficiency of labor. Assume labor—½ value of contents—$50,000	500	Chargeable to mill bldg. only.	
Vermin Losses	100	Chargeable to mill bldg. only.	
Protection against Fire at ½ per cent on value of 30 per cent of Bldg. and Contents—$60,000	300	Applies to mill bldg. only.	
	$11,350		$9,325
Annual Saving of Concrete over Mill Bldg			$11,350
			9,325
			$2,025

Capitalize this at 6 per cent and it represents $33,750.

In other words, a concrete building will save each year 2 per cent over a mill building whose original cost was 10 per cent lower. Stated differently, the owner can afford to pay $43,750 more for a concrete building than for a mill building. The assumptions upon which these comparisons have been made are in the majority of cases moderate. In certain lines of activity the annual saving in favor of concrete would be much higher than that herein calculated.

Concrete is a new material and occasionally there have been failures. These have been due always, however, to inexperience, ignorance, or faulty design. Conservatism may dictate building with steel or brick and wood. Economy and progressiveness point to reinforced concrete.

EDITORIAL COMMENT

Practical Work for Professors.

AMONG those who insist that engineering education (as expressed in American technical schools) is steering wide of the true course, Mr. Fred. W. Taylor has taken a prominent and most positive position. His address before the recent meeting of the Society for the Promotion of Engineering Education was not actually a discussion of Mr. Going's paper, reviewed elsewhere in these pages; it was prepared independently and without knowledge of the substance of Mr. Going's argument. Even more significance, therefore, attaches to the large coincidence between the views of these two contributors. Speaking with an authority of observation and statistical knowledge which none would for a moment attempt to question, Mr. Taylor goes beyond any other critic in asserting that a majority of manufacturers throughout the United States not only have no preference for the technical graduate as an employee, but would distinctly avoid his employment.

Mr. Taylor, although he himself approves of and seeks technical graduates for his assistants, confirms Mr. Going's assertion that at least a year or two of practical experience is necessary to bring the technical graduate into harmony with the temper and the routine of any engineering organization. He confirms further the opinion that this discord in the position of the recent graduate arises partly from the failure of the school to establish, during the educational period, the same relation with superiors and with tasks that must be taken at the moment of entering upon technical employment. He emphasizes, and indeed attaches prime importance to, the question of discipline, which Mr. Going less pointedly indicated by contrast between civil and military engineering education.

Mr. Taylor's principal remedy is addressed to this symptom of lack of discipline. He believes that a year of shop work interpolated in the course, and made obligatory, would be sufficient to implant in the student an acknowledgment of subjection to authority and a recognition of the imperative necessity of producing results, which would go a long way toward giving him a permanent set that would bring him into right relations with his life work after the remainder of his student years was finished. With the utmost respect for Mr. Taylor's opinion, and for the experience upon which it is based, this remedy seems to us inadequate, and from the very nature of things manifestly incapable of working a permanent organic cure. We do not want to give the student an antidote, so to speak, which will make him immune from a diseased condition in the university. We do not want to inoculate him and put him back into an unhealthful atmosphere. We want to make the atmosphere wholesome and invigorating, so that no antidote nor inoculation will be necessary. In brief, the solution is not to leave unchecked within the university those misdirecting forces or policies that Mr. Taylor sees, and to try to counteract them by applying a directing impulse from without. The solution is to make the impulses and tendencies of the university itself direct the student in the proper path. The only men who can do this, wisely, effectively, continuously, are the university faculties. They have the knowledge of methods of instruction, the love of the work, the enthusiasm in it, the genius for systematic and orderly arrangement of mental training, that are indispensable to success.

Without disparaging the value of Mr. Taylor's shop year for the student, we hold to the proposition advanced by Mr. Going, that the shop year for the professor will prove the larger and more efficient influence for bringing university training into parallel with engineering experience and practice.

An Interesting Public Document.

THE North Atlantic Pilot Chart, issued monthly by the U. S. Hydrographic Office, is a well known but none the less remarkable example of the condensation in graphic form of important data and information necessary to navigators. Even a non-technical reader may find therein matter of really absorbing interest, changing with the season and amplified from time to time by new inclusions. The discussion of the movement of tropical hurricanes and of the storm strategy by which the mariner may outmanœuver them and keep his vessel in safety, presented on the back of these charts during the hurricane season, is a clear and vivid bit of writing that catches the interest, holds it engrossed, and leaves it convinced. It would not shame a Joseph Conrad.

To these charts a new department has been added in the form of published questions and answers, heretofore buried in the correspondence files, but now presented publicly so that "the labor and research required to prepare these letters of reply . . . may become effective in a wider sphere." Many of the communications are further explanatory of the subject matter of the chart, and add to its value as the discussion before a technical society adds to the value of a contributed paper. Thus, one of the most useful institutions of technical literature has been applied successfully to the further advantage of a public document, sometimes mistakenly supposed to be lacking in human interest.

The Industrial Flood Tide.

THERE are some curious resemblances, although in an opposite direction, between the movement of the tide of industrial activity which now seems to be on the general rise, and the beginnings of the ebb which set in during the latter months of 1907. At that time we saw, first occasionally, then frequently, and at last generally, retrenchments, cancellations, contractions, which clear-sighted and well-informed observers deplored as unnecessary and unwarranted by any organic conditions in the engineering industries. Nevertheless, in spite of unanswerable intellectual demonstration that contraction was unnecessary, the contraction went on. It was commonly spoken of as a "psychological panic," meaning that it had its origin in an emotional attitude rather than any necessary and inescapable physical conditions.

Now, on the other hand, although deliberative and judicial minds (like those that exhorted against panic) are warning the country against buoyancy, or at least gravely querying whether reasons for buoyancy exist, the contrary-minded industrial activities are obstinately brisking up at a remarkable rate. The great foundation industries of the United States—the steel companies and the railroads—are moving back to normal at a pace which gives the wise and conservative some alarm. Apparently, the recovery is as "psychological" as the panic. At all events, it seems fairly clear that the course of affairs is going to be settled, and settled for prosperity, by influences and tendencies more hopeful, more courageous, and probably after all more nearly right than the intellectual bystanders who stand aloof and shake their heads dubiously—bystanders whose doubts will do as little to delay the flood as their arguments did to stay the ebb.

REVIEW OF THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

THEORY AND PRACTICE IN ENGINEERING EDUCATION.

A PLAN FOR SECURING INTIMATE COMMUNICATION AND PARALLELISM BETWEEN TECHNICAL EDUCATION AND ENGINEERING PRACTICE.

Charles Buxton Going—Society for the Promotion of Engineering Education.

WE have already outlined at some length in these columns the views of Mr. Charles Buxton Going on the subject of engineering education and the adequacy of present methods of training for the demands of practical work. In March, 1908, we reviewed a paper contributed to the *Columbia University Quarterly* on the relation of technical education to industry, in which a plea was made for the recognition of economic results as practically the most important standard for determining the excellence of engineering work. Recently, in a paper read before the Society for the Promotion of Engineering Education, Mr. Going has made a practical suggestion as to how technical education may be brought more closely into touch with actual, practical, working conditions. He argues that instructors in technical subjects should spend one year in every five, or, better still, one in every three, in the actual practice of the profession.

Despite the splendid achievements of the schools of applied science, he says, they are open to the criticism that they have withdrawn too far from intimate contact with practical affairs; in a word, that they have become over-academic. That the graduate in engineering is popularly considered to be incapable of securing from the solution of engineering problems results of economic value without a considerable supplementary training in minor practical positions, is an indication that his training has failed to include recognition of some important elements in the problems he has been taught to solve. Not all his incapacity is attributable to his comparative inexperience. A large part is due to the fact that the school is out of close parallel with life, that too often engineering subjects are not taught as they must be practiced.

For this condition two reasons may be assigned. The first is the persistence of the natural tendency to cling to old forms and methods of education or to change them as little as possible in applying them to new subject matters. Unfortunately the old academic temper has always been fearful, if not intolerant, of anything utilitarian or commercial, and some lingering vestiges of this old mood have made our technical schools reluctant to recognize and to teach economic limitations as clearly as scientific standards of perfection. The engineer is given in the school too academic a devotion to scientific perfection on the one hand, and, on the other, an inadequate idea of the imperative character of costs.

"It is not for a moment desirable that the vision of the goal set by pure science be obscured, but only that the understanding be increased of the approximations which it is expedient to accept in actual performance, and the conditions

by which they are determined. Every one must wish the student of mechanical engineering to possess sufficient knowledge of the science to understand what has been done and to take an intelligent part, if necessary, in continuing it. But the choice of power plant in any given case depends on a careful comparison of the net total of interest on investment, expense of maintenance, depreciation, wages of skilled attendants, and fuel costs. The design of a piece of machinery may require a sound, scientific knowledge of mechanics and kinematics, a careful mathematical calculation of stresses and weights, and a high degree of skill at the drawing board. But if cost of construction is important—and it usually is very essential—it requires also attention to economy in the use of the material and especially of the labor involved in manufacture; the selection of stock sizes; the standardization of gears, arbors, bores, tapers, bolts and screws; avoidance of difficult problems in pattern making and molding, and minimization of labor in machining and assembling of parts. Does the average course impress the student with these common-sense considerations in the handling of materials as strongly as it does with theoretical mechanics or the technique of draftsmanship? Can it possibly do so, until the economics of engineering are given an entity in the curriculum, and made to occupy an arc of the educational horizon as large as that which they will fill in the graduate's discovery of his life work?

"Yet the very analogies I have cited would prove that this evolution of the scientific school to exact adaptation to its environment would proceed with reasonable rapidity were it not for the second obstructive influence at which I have hinted. This is the jealousy of the universities which make them debar the members of their faculties from mingling in practical affairs. This situation becomes like that which might result if the merchant marine companies or the navy department discouraged their deck officers from familiarizing themselves with the use of steam. While the colleges have been unable to offer rewards large enough to compensate an able specialist for resigning independent work in his profession, they have discountenanced or discouraged his combining outside practice with university service. It is vastly to the credit of our professors that in spite of this disadvantage they have maintained so active and earnest an interest in all contemporary developments; but without the competitive participation and the daily intercourse that constantly sharpens the edge of the consulting engineer's knowledge, the college man is almost of necessity prevented from maintaining more than an academic familiarity with the broad range of subjects he is expected to teach. His assistants, further, upon whom the students must depend chiefly for personal instruction and individual contact with their technical work, are usually drawn—and by budget necessity must be drawn—from a class of men whose experience is scarcely a step in advance of that of the undergraduates themselves.

"Now, criticism which is not constructive fulfills only half a function. Let me attempt the dangerous service of suggestion. A traditional institution of the universities is the professor's Sabbatical year, in which he is supposed to travel and to familiarize himself with the work done in his subject elsewhere. Suppose that, recognizing the relatively high rate of progress in the applied sciences, these Sabbatical periods in the technical faculties were reduced to five years, or, better still, to three; and that the teacher were requird to spend each third or fifth year, *not* in sojourning at other universities, working in other laboratories, hearing other lectures, and seeing how his subject is *taught* —but in active work as an official or *attaché* in a railway organization, a bridge or construction company, or a manufacturing plant, seeing how the things he teaches are actually *practiced*. Salary would be immaterial, as his full income from the university would be continued; opportunity for the widest and closest possible contact with work in the field under 'all the conditions there are' would be everything. I owe

the completion of this concept to the active executive manager of one of our largest manufacturing corporations. His enthusiastic approval of it goes far to indicate the cordial co-operation that would be given by business interests in making such a plan operative. To them it would bring not only the valuable aid of the university man's trained faculties, but the prestige of association with colleges of high standing and repute. To them, also, would soon accrue another advantage in the higher usefulness of the graduates turned out from the college to enter industrial or engineering service. To the professor would be opened the most fertile and most instructive working and research laboratories where experiments on a full-sized scale, backed by an endowment such as he never could dream of controlling, were spread before him in full operation twenty-four hours of the day. And think of the assured grasp of the latest ideas and methods, the freshness of viewpoint, and the energy of demonstration with which each man would return to his classes after a year in the field. This would be a sort of university extension that would keep engineering education and practice in intimate communion and in constant parallel.

"In so far as any lack of proportion or of balance may exist in the resultant of the present technical courses, it is probably due to a disposition so admirable that one hesitates to call it a defect—that is, the passion for thoroughness actuating every member of the faculty, each in his department. But, after all, I do not know that what we teach is so important as how we teach it. The question is not so much of the functional performance of our engineering schools as of their organic constitution. Are we doing the best that can be done, or all that should be done, to establish right relations between the faculty and the profession, and between the student and the faculty, or to introduce the student to the atmosphere, the viewpoint, the spirit of his life-work?

"Although engineering, whether static or dynamic, demands organization more nearly like the military form than any other civil occupation, our engineering courses try to mold men for this most active and energetic pursuit by methods inherited from the cloister and the cell. We make laboratory, shop and field scarcely more than an annex to lecture-room and study. We assume to a very large extent that a system excellent for teaching theology, the classics, letters, and perhaps pure mathematics, will serve for teaching railway engineering, superintendence of a power plant, or shop administration, by the mere change of text books and of topics discoursed upon from the lecturers' platform. We attempt to develop that 'objective, synthetic' habit of mind of which I spoke some time ago by a mode of training evolved to reach the ideal of a subjective, analytical mentality. It takes our students some years of after training to learn to be something more than analytical and critical and to get down to things. In short, the boy entering Annapolis or West Point steps at once into the life of the navy or the army and becomes a part of it. His graduation is merely a step forward in the same direction. The boy entering one of our engineering schools usually steps into something totally *unlike* an engineering corps, a manufacturing shop, or the motive-power department of a railway. His graduation is a plunge into a strange and bewildering stream moving in an entirely new direction.

"The change, therefore, that I think will bring us nearer to truth is not one of detail; it is fundamental. It cannot be accomplished easily. Nevertheless, somewhere in that direction, I think, lies the way to the great technical school of the future. We shall begin to work towards it when we devise some plan by which our engineering teachers will live nearer to our practicing engineers. We will grow nearer to it when, in our schools of applied science, a closer fellowship is established between 'town and gown.' The jealousy of many universities, which discourages the teacher from maintaining close touch with active professional work, as already suggested, is one of the regrettable influences forcing our practical sci-

ence courses out of parallel with the progress of industry. A more weighty one still perhaps is the small opportunity given the alumnus to be heard in university councils and to bring back within university bounds the fresh spirit and suggestion of the constantly changing world without. The result is an inevitable set toward formalism and scholasticism on one side, and toward apathy on the other. Through freer, wider, and more frequent intercourse between faculty and alumni, probably more effectually than in any other way, will the evolutionary forces of the wonderful system of technical education be kept vigorous and instantly responsive to the demands of industrial life."

CANAL BUILDING IN EUROPE.

A SUMMARY OF WORK IN PROGRESS AND PROJECTED FOR THE IMPROVEMENT OF INLAND NAVIGATION FACILITIES.

Engineering.

INLAND water transportation is generally known to be conducted in Europe on a very large scale, but few have an adequate conception either of the extent to which facilities for inland navigation have been developed by the governments of the various countries, or of the magnitude of the improvements which are now under way or in contemplation. An editorial review in *Engineering* for May 7 gives a brief summary of present activity, from which we quote at length.

"What is being done in the matter of water carriage all over the world was well shown at the eleventh International Navigation Congress at St. Petersburg last summer. That city was a fitting place for the meeting, because, judged by the length of her artificial water courses, Russia leaves all the other countries far behind. The length of Russian canals, estimated at 173,000 kilometres (107,500 miles), in fact exceeds the total length of the canals of the other European countries and of the United States by about 51,000 kilometres (32,000 miles). In that estimate the United States are credited with 33,688 kilometres of canals, Germany with 24,159 kilometres, France with 21,561 kilometres, Great Britain with 13,087 kilometres, the Netherlands with 8,087 kilometres, Sweden with 7,211 kilometres, Austria with 6,461 kilometres, and Italy with 3,550 kilometres. The length is, of course, not a criterion of the importance of a water course. But Russia is making notable efforts to develop its shipping and to improve its ports.

"In some of these efforts the Russian and the Austrian governments are cooperating. This work concerns the regularisation of the Vistula, whose upper courses are in Austrian territory. The German Government is likewise interested in those operations, as a navigable canal joining the Danube to the Oder, which also rises in Austria, but is essentially a Prussian river, and to the Vistula, is being projected. Austria is further engaged in the regularisation of the March, or Morava, which joins the Danube together with the Thaya, and of the Danube itself. The Danube canal, which traverses the city of Vienna, has been provided with barrages and locks, which protect the Vienna docks against floods and drifting ice; another great winter port has been created at Linz, situated on the Danube, above Vienna. Regularisation is also being carried out on the Moldau, or Moldava, the river on which Prague is situated, and on the Elbe, into which the Moldava flows. The position is, however, so far peculiar, as the Austrian Government hesitates to spend the grants which the legislative bodies have made. The Government objects that the designs and the estimates on which the designs were based are not sufficiently reliable. As the recent expert reports confirm those previously made, however, it is expected that operations will no longer be delayed, especially in the Danube-Oder canal.

"In Hungary protection against floods is a more serious problem than the promotion of shipping, though the Danube

is certainly a waterway of the very first order. The canalisation of the main rivers and their tributaries already settled concerns 7,000 kilometres (over 4,000 miles) of rivers. What has been done at the Iron Gates, and in connection with the regular canalisation of the Danube for many miles above the Gates, need not be repeated on this occasion.

"The great improvements which Germany is effecting in its ports, canals, rivers, and on its coasts, have also been referred to in our columns. The Prussian Parliament of 1905 did not approve of the full scheme of a West-East Canal, which was to link all the great rivers flowing northward. But it placed 25 million pounds at the disposal of the Government for the benefit of agriculture and shipping. The necessary negotiations and the projects are nearly complete, and operations have been started on the Canal Berlin-Stettin and on the Rhine-Hanover Canal. Great reservoirs are to be created near the sources of the Weser River, sufficient to feed the Weser section of the West-East Canal. Locks have been built on the Upper Oder, comprising twelve new locks fitted for haulage service. The electric traction, introduced on the new Teltow Canal, near Berlin, has excited general attention, and the Warthe and Netze, tributaries of the Oder, from the east, which pass through many miles of what used to be hopeless swamps, are being canalised for vessels of 450 tons burden. At an expenditure of 11.5 million pounds, the Kaiser Wilhelm Canal, cut through Holstein to join the Baltic to the Lower Elbe and the North Sea, is to be rendered navigable for the largest modern warships. Much has also been done for the lighthouse service of the German coasts, the number of lights having been increased and their intensity considerably raised. The old Hansa towns—Hamburg, Bremen and Lübeck—have spent large sums on the improvements of their ports, and now the former two can rely on 10 metres (32 feet 9 inches) of water at low tide. The municipality of Harburg, on the Elbe, is building a great port there, and the Prussian Government is doing the same for Emden, situated on the Dollart (a bay of the North Sea) in the estuary of the River Ems. The harbour works of Ruhrort, now finished, make this port one of the world's greatest inland dock centres.

"South Germany is not behind. The wide and deep, but winding, Rhine is being regularised for large vessels on the reach Mannheim-Strassburg, and the Main is to be canalised from Offenbach, near Frankfort, up to Aschaffenburg. The fate of this latter project and of several others will depend upon the final settlement of the shipping dues question. The traffic on the rivers and canals of Germany represented in the year 1905 about 15 thousand million (15,000,000,000) ton-kilometres, and the transport by water has continued to increase.

"The Netherlands, the country which could not exist without hydraulic engineers and which prospers, thanks to their efforts, are doing their best for the great ports of Amsterdam and Rotterdam. The Ymuiden-Amsterdam Canal, which we have described, is being excavated to a depth of 10 metres and widened so as to take the largest vessels right into the docks of Amsterdam; and Rotterdam is going to build a new Waal port of 760 acres area, which will rank with the most extensive of the globe.

"At the end of 1903, when the projects of Freycinet called for a further expenditure of 170 million francs, France voted 300 million francs, of which 128 million were to be spent on the sea ports, the rest on the improvement of inland navigation. More than half of this sum—viz., 165 million francs—had been spent by 1907, the maritime ports claiming 106 million. The ports of Havre and St. Nazaire, which have been provided with new entrances, and Dieppe, Dunkerque, Boulogne, Rouen, Nantes, Bordeaux, and Marseilles have particularly benefited; but more money has since been granted, and the colonial ports of Algiers, Tunis, Dakar (Cape Verde), and Diégo-Suarez (Madagascar) are also being improved.

"Belgium had in the years 1907-1908 sums of 53 million francs at its disposal, about half for inland navigation and half for sea ports. The harbour improvements at Antwerp, which have cost 16

million francs in the years 1906 to 1908, are not included in these estimates, nor are other essentially municipal operations. The maritime ports of Ghent (Gand), Brussels, Bruges, Zee-Brügge, and Ostend are practically complete. The inland canalisation work indicates, in part, the connection with northern France, which is doing its share in these improvements.

"The terrible disaster which has befallen the Straits of Messina may modify the projects which Italy was carrying out in accordance with the grants of 32 and 13.5 million francs of the year 1904, and of 137 million francs of 1907. The sums were to be expended on the ports of Livorno, Naples, Brindisi, Lido (Venice), Palermo, and Messina; Civita Vecchia and Savona have also drawn on these funds, while Genoa has been able to raise 15 million francs during the past four years for her port.

"The Spanish Government has not been able to do much except for harbours of refuge; most of the Spanish ports are under the control of commissions, known as *juntas de obras*. Portugal has not been in a position to effect noteworthy innovations either. The formerly Portuguese and Spanish colonies in South America are more active. The ports of Manaos, Santos, Bahia, and Rio de Janeiro, also Para and Pernambuco in Brazil, Montevideo in Uruguay, Buenos Aires, Rosario, and La Plata, in the Argentine Republic, are undergoing improvements which will be much appreciated. Tenders have quite recently been invited for a canal, 36 miles in length, including canalisation of the Lugan River for 11 miles, to join Buenos Aires to the Rio Paraná de las Palmas; the depth is to be 28½ feet.

"The progress realised in Sweden has repeatedly been commented upon in our columns. The utilisation of the water-power of the Trollhättan, and of the Göta-Aelf, which the Government has also bought, is being extended, and will make nearly 200,000 horse-power available. In connection with this huge scheme, which will afford another characteristic illustration of the competition between black and white coal, the famous Trollhättan Canal is being rebuilt."

A MACHINE FOR TESTING TOOL STEELS.

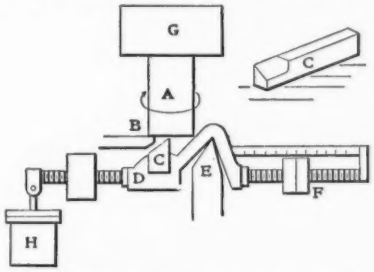
THE CONSTRUCTION, OPERATION AND APPLICATION OF A NEW DEVICE FOR MEASURING THE CUTTING POWER AND DURABILITY OF TOOLS.

Edward G. Herbert—American Machinist.

THE common method of testing tool steel, as carried out in the workshop, is to set a tool at work in a lathe and observe how long it retains its edge, the weight of metal it removes and the cutting speed which can be attained. Although the process is apparently simple, it is extremely difficult to obtain results of even approximate accuracy. Indeed, so real is the difficulty that steelmakers, who are themselves unable accurately and conveniently to test their own products, find it hard to induce prospective customers to make a trial of their steels. Both manufacturers and users, therefore, should benefit materially by the introduction of a machine for the testing of tool steels, recently invented in England. A description of the device and a summary of the more important results already obtained are taken from an article by Edward G. Herbert in the *American Machinist* for May 20.

"The principle of the tool-steel testing machine will be readily understood with the aid of the diagram, in which *A* represents a tube, usually of steel, ¾ inch in diameter and ⅝-inch bore, revolving about a vertical axis in the direction indicated by the arrow, with its lower end resting on a fixed abutment *B* of hardened steel. The steel to be tested is made into a tool *C* which, as shown in the perspective view, is ground something like a left-hand side tool. The tool is held in a vise *D* which is balanced on knife edges represented diagrammatically by *E*. Attached to the vise is a steelyard *F* with a movable poise and scale. A dash pot *H* steadies the vise and tool, and prevents vibra-

tion. By a suitable adjustment of the poise on the steelyard, the tool can be caused to press upward against the end of the tube with any desired force. The tube is held down in the abutment *B* by the weight *G*, and the downward pressure is always in excess of the upward pressure of the tool, so that the tube, as it is turned away by the tool, is constantly fed downward and kept in contact with the abutment *B*. The point at which cutting takes place is, therefore, stationary. The tool continues to turn away the tube as long as it remains sharp enough to penetrate the metal, but eventually it attains that definite degree of bluntness at which its upward pressure against the tube is no longer sufficient to cause it to cut, and it then slips over the surface of the tube without further cutting action.



DIAGRAMMATIC VIEW OF THE TOOL STEEL TESTING MACHINE.

"The tube is driven by a vertical spindle, which receives its motion through cone and friction disk gearing, capable of giving it a wide and continuous range of speeds. A drum covered with squared paper is driven from the spindle through worm and spur gearing, so as to make one revolution to 24,000 revolutions of the spindle. A pencil mounted on a sliding bar is connected to the spindle by a fine chain, so that vertical movements of the spindle are communicated to the pencil. The combined movements of the drum and pencil result in drawing a line on the paper, whose slope measures the rate at which the spindle moves downward; that is, the rate (in inches per 1,000 revolutions) at which the tube is being turned away by the tool. When cutting ceases, the line becomes horizontal, since the drum continues to revolve, while the pencil remains stationary.

"Now suppose the hardness of the tube and the speed at which it is driven, the rake and clearance angles of the tool and the force with which it is pressed against the tube, are all exactly known and constant; then the tube will be cut away at a certain definite rate which will be shown by the slope of the line drawn, but any variation in any one of the conditions will be shown by a variation in the slope, which thus acts as an absolute check on the uniformity of the conditions.

"There is one remaining conditions besides those enumerated above, which is variable and which affects the rate of cutting; namely, the sharpness of the tool. This varies at a rate which depends (other things being equal) simply on the quality and temper of the steel of which it is made. Owing to the vise being balanced on knife edges, loss of sharpness can only take place up to a certain definite degree of bluntness, measured by the slipping of the tool. Therefore, the number of revolutions made by the tube before this slipping takes place is an exact measure of the quality of the tool steel.

"In practice one side of the tool is ground perfectly flat and is held against the fixed jaw of the vise. A pointer is attached to the vise, and by setting this to an index mark, the fixed jaw is brought to a vertical position, with the tool in contact with the tube. Set in this position, the tool has no rake. It is ground with a clearance angle of 20 degrees. This form of tool is adopted partly for the sake of simplicity. It involves the grinding of only one angle and is easily set. It is not the most efficient form for cutting, but this is in itself an advantage, as an inefficient tool is worn out sooner than an efficient one, and the object is not to cut away the maximum amount of stock, but to wear the tool out in a reasonably short time under standard conditions, measuring its quality by its resistance to wear. The angles of the tool can, however, be varied if it is desirable. If the test tube is of soft steel the tool must have some rake, in order to make a clean cut with-

out burring the tube and so increasing the width of contact of the cutting edge. Rake can be provided for with the same type of tool, by the use of vise jaws tapered at the desired angle.

"It might at first sight appear that a good tool would turn away a great length of tube before becoming blunt. That this is not so in practice is due partly to the shape and position of the tool, and partly to the composition of the test tube. The latter is made of a special steel containing 0.6 per cent carbon, 0.83 per cent manganese, and 0.21 per cent silicon. This steel has great wearing properties, and it is subjected to a special heat treatment which gives it considerable hardness and great uniformity. A good tool will be blunted by turning away a few inches of this steel, the feed being usually about 0.001 inch per revolution."

The experiments made with the machine so far have been arranged principally with a view to indicating the directions in which research may be usefully carried out. Nevertheless, some highly interesting practical results have been obtained. The first series of tests was designed to prove the reliability of the machine by comparing the cutting qualities of tools carefully ground from ordinary carbon steel and from a very good high-speed steel. Tools with no rake and 20 degrees clearance were tested under the same conditions, with 15 pounds pressure and a cutting speed of 30 feet per minute, under a copious flow of water. Both tools cut at the same rate, as was anticipated, but an unexpected feature of the test was that the carbon steel lasted four times as long as the high-speed steel. A large number of tests at this cutting speed gave always the same result: the cast steel did several times as much work as the high-speed steel. When the cutting speed was increased from 30 to 40 feet per minute, however, the high-speed steel did twice as much work as the carbon steel.

Tests were made on a number of tools cut from various steels, at cutting speeds ranging from 12 to 120 feet per minute, all the other conditions remaining constant. None of the tools would cut at all at the lowest speed under the pressure of 15 pounds. As the speed progressively increased, the amount of metal removed per revolution increased, and there was also an increase in the amount of metal removed before the tool became too blunt to cut. At the higher speeds the tools continued cutting until they were in a very bad condition, while at low speeds they slipped as soon as the edge was very slightly worn. This puzzling phenomenon has since been confirmed in many ways in the machine shop.

When tests of a number of tools had been made at various speeds, the results were plotted out in the form of a single diagram in which the vertical distances represented the number of revolutions made by the tube before the tool slipped, and horizontal distances, cutting speeds in feet per minute. Starting at 12 feet per minute, at which speed none of the tools would cut, the "speed curve" of the cast steel rises at once and attains its maximum height at 55 feet. All the high-speed steels show a very gradual slope, with a durability several times less than that of the carbon steel up to a speed of 30 feet or more, and then rise suddenly very high above the cast steel.

The speed curves give a correct comparison of the durability of the steels at any given speed, but they do not show the relative durability of the same steel at different speeds. A micrometer attachment was devised for measuring the amount of wear of the tool while cutting is in progress, and from the information obtained by this means a set of equal-wear speed curves was constructed. The most striking and important fact brought out by these curves is that very low speeds are no less destructive of the edge of a cutting tool than very high speeds. This appiles to every kind of steel tested. It is a familiar fact that high-speed steel does not keep its edge well under light finishing cuts. The speed curves show that a good high-speed steel preserves its edge under a very light cut better than a carbon steel *if the speed is sufficiently high.* This fact, that the durability of a tool can be increased by in-

creasing the speed has been applied with marked success in the operation of the workshop. The peak of the speed curves, where the durability of the tool is at its maximum, covers a narrow range of speeds, and the durability falls rapidly as the speed goes above or below these narrow limits.

Comparison of the rate of removing metal is obtained by the construction of "duty curves." "Duty" is the product of the durability at any speed and the speed itself; it is proportional, therefore, to the rate at which metal is being removed. Duty curves give valuable information as to the influence of the various ingredients in the steel and of various methods of working it, on its working properties.

Although experiments undertaken to determine the relation of cut and speed with reference to their influence on the wear of the cutting tool have not yet been completed, it is possible to anticipate with considerable confidence the general form which this relation will assume. There seems little doubt that durability of a cutting tool is almost entirely dependent on the rate at which heat is generated in cutting, and this being so it follows that the durability of the tool will be the same for any combination of cut and speed which generates the same amount of heat in a given time. Theoretical considerations lead to the conclusion that the rate at which heat is generated by a unit length of cutting edge is proportional to the thickness of the chip multiplied by the cube of the cutting speed. If C_1, S_1 are the thickness of the chip and the cutting speed, respectively, at any point on the speed or duty curve, C_2 the thickness of the chip which is to be made in practical working, and S_2 the corresponding speed, then the relation will be expressed by the formula,

$$C_1 S_1^3 = C_2 S_2^3,$$

whence

$$S_2 = S_1 \sqrt[3]{\frac{C_1}{C_2}}.$$

In applying this formula, however, the character of the steel, the shape of the tool and the ratio between the width and thickness of the chip have to be taken into account.

Besides its primary function of measuring the quality of tool steels, the testing machine opens a wide field of inquiry into all phenomena connected with the action of cutting tools. Among the investigations to which it is particularly adapted may be mentioned the determination of the effect of rake, clearance and slope in relation to efficiency and durability, and the effect of lubricants on the wear of cutting tools. It may also be applied to the determination of the resistance to wear of metals in frictional contact and to the measurement of hardness.

THE COST OF PRODUCING STEEL IN FOUNDRIES.

THE FUTURE RELATION OF ELECTRIC STEEL-MAKING PROCESSES TO PRESENT METHODS.

Bradley Stoughton—American Foundrymen's Association.

THE table of costs of producing steel in foundries, given on the next page, has been compiled from nine tables, dealing separately with the various processes, contained in a paper read by Dr. Bradley Stoughton at the recent meeting of the American Foundrymen's Association. The chief object of Dr. Stoughton's study was not particularly to publish the cost of making steel for castings, but to consider the future relation of electric steel-making processes to present methods of foundry work, a subject in which there are many indications of a lively interest on the part of the steel-casting industry. All his tabular data are presented in condensed form in the table appended; we give also an abstract of his comment on the various processes.

In the table the prices of raw materials, figured on the basis of a short ton, were those current in Pittsburg the first week in May, 1909. It is not expected that the prices and weights given will be accepted by every one as representative of his practice, but the items can easily be altered to suit each

TABLE SHOWING COST OF PRODUCING STEEL IN THE FOUNDRY BY VARIOUS PROCESSES, PER 2,000 POUNDS OF STEEL IN THE LADLE.

A, acid open-hearth process. B, basic open-hearth process. C_1 and C_2, acid and basic open-hearth processes when together in the same plant. D, converter process. E, converter process with large waste. F, acid open-hearth process for small castings. G_1 and G_2, basic open-hearth process for small castings. H_1 and H_2, crucible process. I, electric process.

Raw Materials.	A	B	C_1	C_2	D	E	F	G_1	G_2	H_1	H_2	I
Pig iron.												
Price per 2,000 pounds.....	$14.00	$12.75	$14.00	$12.75	$14.00 $17.40	$14.00 $17.40	$14.00	$12.75	$12.75	....	....	....
Weight used, pounds.....	300	1040	300	1040	300 1280	300 1360	300	1040	1040	....	....	....
Per cent used.....	15	52	15	52	15 64	15 68	15	52	52	....	....	....
Cost	$2.10	$6.63	$2.10	$6.63	$2.10 $11.14	$2.10 $11.83	$2.10	$6.63	$6.63	....	....	....
Wrought iron.												
Price, per 2,000 pounds.....	....	....	....	....	....	....	....	....	....	$25.50	....	....
Weight used, pounds.....	....	....	....	....	....	....	....	....	....	1360	....	....
Per cent used.....	....	....	....	....	....	....	....	....	....	68	....	....
Cost	....	....	....	....	....	....	....	....	....	$17.34	....	....
Heads, gates, etc.												
Price per 2,000 pounds.....	$14.00	$14.00	$14.00	....	$14.00	$14.00	$14.00	$14.00	$14.00	$14.00	$14.00	$14.00
Weight used, pounds.....	660	660	1320[b]	....	660	660	660	660	660	660	660	660
Per cent used.....	33	33	66	....	33	33	33	33	33	33	33	33
Cost	$4.62	$4.62	$9.24	....	$4.62	$4.62	$4.62	$4.62	$4.62	$4.62	$4.62	$4.62
Foreign scrap.												
Price per 2,000 pounds.....	$14.50	$11.15	$14.50	$11.15	....	....	$14.50	$11.15	$11.15	....	$14.50	$9.50
Weight used, pounds.....	1080	350	420	1010	....	....	980	190	91	....	1330	1330
Per cent used.....	54	17.5	21	15.5	....	....	49	9.5	4.5	....	66.5	66.5
Cost	$7.83	$1.95	$3.05	$5.63	....	....	$7.11	$1.06	$0.51	....	$9.64	$6.32
Defective castings from bad metal.[a]												
Price per 2,000 pounds.....	$50.00	$50.00	$50.00	$50.00	$80.00	$80.00	$50.00	$50.00	$50.00	$125.00	$125.00	$125.00
Weight used, pounds.....	20	40	20	40	20	20	120	200	300	10	10	10
Per cent used.....	1	2	1	2	1[d]	1	6	10	15	0.5	0.5	0.5
Cost	$0.50	$1.00	$0.50	$1.00	$0.80[d]	$0.80	$3.00	$5.00	$7.50	$0.63	$0.63	$0.63
Ferro-alloys.												
Price per 2,000 pounds.....	$40.60	$40.60	$40.60	$40.60	$40.60	$40.60	$40.60	$40.60	$40.60	$40.60	$40.60	$40.60
Weight used, pounds.....	29	33	29	33	35	38	29	33	33	12	12	12
Per cent used.....	1	1.5	1	1.5	2	2	1	1.5	1.5	0.5	0.5	0.5
Cost	$0.59	$0.67	$0.59	$0.67	$0.71	$0.77	$0.59	$0.67	$0.67	$0.24	$0.24	$0.24
Total metal.												
Weight used, pounds.....	2089	2123	2089	2123	2295	2378	2089	2123	2124	2042	2012	2012
Per cent used.....	104	106	104	106	115	119	104	106	106	102	100.5	100.5
Total cost.....	$15.64	$14.87	$15.48	$13.93	$19.37	$20.12	$17.42	$17.98	$19.93	$22.83	$15.13	$11.81

Operating Costs	{ $5.50[b]	{ $6.10[b]	$5.50	$6.10	{ $ 3.50[a]	{ $5.50[a]	{ $5.50[b]	{ $6.10[b]	{ $6.10	$35.00	$35.00	
	{ $8.85[b]	{ $9.55[b]			{ $5.50[a]	{ $8.85[b]	{ $8.85[b]	{ $9.55[b]	{ $9.55			
Cost of Steel in Ladle	{ $21.14	{ $20.97	$20.98	$20.03	{ $22.87	{ $23.63	{ $22.92	{ $24.08	{ $26.03	$57.83	$50.13	Cost of electric power per k.w.h. cents.
	{ $24.49	{ $24.42			{ $24.87	{ $25.62	{ $26.37	{ $27.53	{ $29.48			Cost of steel in ladle.
Cost of Steel in Castings.												Cost of steel in castings.
Cost of steel in ladle÷65%[c]	{ $32.52	{ $32.26	$32.33	$30.81	{ $35.18	{ $36.34	{ $35.26[f]	{ $37.05	{ $40.05	$87.62[g]	$76.95	1 $28.81 $39.03
	{ $37.68	{ $37.57			{ $38.26	{ $39.42	{ $40.41	{ $42.35	{ $45.85			2 37.96 52.89
												3 47.11 66.76
Less credit for heads, etc., as scrap	$4.62	$4.62	$4.62	$4.62	$4.62	$4.62	$4.62	$4.62	$4.62	$4.62	$4.62	4 56.26 80.62
												5 65.41 94.49
Net cost of steel in castings	{ $27.90	{ $27.64	$27.66	$26.19	{ $30.56	{ $31.72	{ $30.64	{ $32.43	{ $35.43	$83.00	$71.33	
	{ $33.06	{ $32.95			{ $33.64	{ $34.80	{ $35.79	{ $37.73	{ $40.73			

[a] The price given for defective castings is over and above their value as scrap.
[b] The lower charge is the figure for a 25-ton furnace and large tonnage; the higher, that for a small furnace and small production.
[c] Of the steel in the ladle, 65 per cent goes into castings, 33 per cent into heads, gates, etc., and 2 per cent is lost in spattering, etc.
[d] The per cent of defective castings in converter practice will be less than this, and the cost will be somewhat lower. In the absence of average figures it is charged the same as acid open-hearth.
[e] The lower charge is for one 2-ton converter making 150 tons per week; the higher is for a 2-ton converter with small production.
[f] The loss in pouring small castings will probably be much larger than the 2 per cent mentioned in footnote c.
[g] The divisor in this case is 66 per cent.
[h] This figure represents the heads, gates, etc., produced from the operation of both furnaces.

individual case. The item of heads, gates, etc., will depend largely on the class of work; 33 per cent has been adopted for all processes to make this item comparative. The item of defective castings chargeable against the furnace, as distinguished from those chargeable to bad molding, which are included in the item of heads, gates, etc., will also vary greatly in different places, and it is probably impossible to estimate an average figure either for the percentage made or for the price.

The cost of steel making by the acid open-hearth process is shown in column A. The charge of $5.50 for operating costs per ton is for a 25-ton furnace operating at maximum capacity. There is no doubt that in some practice better results are obtained, and this figure can hardly be accepted as a minimum. Neither can $8.85, the charge for small furnaces and furnaces worked at low capacity, be taken as a maximum. The cost of operating some furnaces is undoubtedly higher.

In column B is shown the cost of the basic open-hearth process. For several reasons the difference in cost between the acid and basic open-hearth processes is less in this example than will ordinarily be found in practice. Chief among them is the fact that the basic open-hearth process is here under the disadvantage of having to use 33 per cent of its own heads and gates, which command a higher price in the market than scrap suitable for the basic process. This condition explains the common practice of operating both a basic and an acid furnace in the same plant, the economy of which is shown in columns C_1 and C_2. The acid furnace uses the scrap from both furnaces at a favorable figure, thus allowing a larger proportion of cheaper basic scrap to be purchased outside.

The cost of converter practice is shown in column D. The operating cost of $3.50 per ton applies to the making of 150 tons of castings per week in one converter. The second figure of $5.50 per ton would apply under exceptionally uneconomical conditions of operation. In column E is given the

cost of steel making in the converter, with a loss of 19 per cent instead of 15 per cent. The latter is rather a low figure. It will be observed that the converter process cannot compete on even terms with either of the open-hearth processes. Its special field is the production of small castings, in which, on account of the large percentage of defective castings made, the open-hearth processes are less economical. In columns F, G_1 and G_2 are shown the costs of producing small castings by the acid and basic open-hearth processes.

Wherever the electric steel-making process has been introduced, with one or two exceptions, it has supplanted the crucible process, the cost of which is shown in columns H_1 and H_2, the former showing the cost when melting wrought iron, and the latter the cost when melting low-phosphorus steel scrap. An important consideration in the substitution of the electric for the crucible process is that the cost of the installation for the former is at least ten times as great as that for the latter. The electric process has, however, two great advantages. It can use the cheapest form of steel scrap available in the market; and it can turn out the highest grade of steel made. The cost of the electric process is shown in column I for five different rates for electric energy, the largest item of cost.

"It is evident that the electric process can hardly hope to compete in cost of production with any of the prevailing processes except the crucible process, and then usually only when electric power is available at 3 cents per kilowatt-hour or less. It may well be, however, that recent developments in the electric process will bring its cost down to the point where the converter process will be superseded to some extent, especially in view of the very high quality of electric steel. This question, however, is not to be taken in any sense as a prophecy. The cost of the electric process available only for large tonnages of castings is materially lower than that given above, but the cost of installation of this type of electric furnace is so large that many immediate replacements are not probable."

CARBON MONOXIDE AS A CASE-HARDENING AGENT.

RESULTS OF RESEARCHES UNDERTAKEN TO DEMONSTRATE THE CASE-HARDENING EFFECT OF CARBON MONOXIDE.

M. G. Charpy—Revue de Métallurgie.

DISCUSSION of the case-hardening effect of carbon monoxide, during the last half-century, has attained at times almost to the dignity of a controversy. The effect was first noted by Margueritte in 1864, to be denied and reaffirmed by a succession of subsequent experimenters. M. G. Charpy contributes to the *Revue de Métallurgie* for May an account of the controversy, with the results of some experiments of his own which definitely establish the fact that carbon monoxide has a well-defined case-hardening effect on steel. These tests are outlined in the following brief extracts from M. Charpy's paper.

The experiments consisted in heating iron at different temperatures in a current of pure carbon monoxide. The metal, usually in the form of wire 0.3 to 0.5 millimetres in diameter or fine iron filings, was placed in magnesia holders in porcelain tubes heated by a platinum-resistance electric furnace, supplied with electrical energy by a battery of accumulators. The temperature was measured and regulated by means of a Le Chatelier pyrometer. The carbon monoxide employed was prepared by the action of sulphuric acid on ferrocyanide of potassium and then absorbed by a solution of copper chloride. The gas was driven out of the solution by heat into large gasometers. Before being applied to the iron, the gas was passed through a tube heated by an electric furnace and containing copper filings, to remove the last traces of oxygen; it was also passed through tubes containing silver nitrate and soda lime. After leaving the tube containing the metal, the gas was once more passed through a tube

containing soda lime, the variation in weight of which was noted for each test; the gas was then led to containers for further use.

In each test was determined the weight of carbon dioxide formed, the increase in weight of the metal, and the carbon absorbed by the metal, the latter determination being made by heating the metal in the presence of oxygen and deducting from the total amount of carbon found the amount originally in the iron. These three methods of determining the amount of carbon absorbed gave in each case approximately the same result. The table gives under "carbon absorbed" the average of the three results.

Further experiments were made on a mild steel tube 10 millimetres in diameter. After 60 hours of heating in a slow current of carbon monoxide, samples for analysis were turned off in a lathe. The mean carbon content of the outside layer, one millimetre in thickness, was found to be 0.63 per cent, while that of the metal beneath this layer was found to be 0.5 per cent. Another test under similar conditions but without circulation of the gas gave a mean carbon content of the outside millimetre of 0.2 per cent, and of the second millimetre of 0.15 per cent, the initial percentage of carbon being 0.12.

TABLE SHOWING AMOUNT OF CARBON ABSORBED BY STEEL FROM CO AT VARIOUS TEMPERATURES.

Temperature, Degrees C.	Metal.	Time of test, hours.	Carbon absorbed, grams.
560	B	8	0.09
600	A	8	0.20
715	A	8	0.27
825	B	3	0.58
900	C	2	0.62
900	C	3	0.52
925	B	3	0.71
925	C	5	0.63
935	B	2	0.43
1,000	C	2	0.48
1,000	C	3	0.57
1,025	A	2.5	0.59
1,050	B	2	0.45
1,085	B	2	0.55
1,125	B	2	0.48
1,175	B	2	0.49
1,185	B	2	0.51
1,190	B	2	0.33

A. Piano wire with 0.04 per cent carbon.
B. Open-hearth mild-steel wire, carbon 0.09 per cent, manganese, 0.25 per cent, phosphorus, 0.015 per cent, sulphur, 0.1 per cent, and silicon, trace.
C. Fine mild steel filings, carbon, 0.07 per cent, manganese, 0.3 per cent, phosphorus, 0.02 per cent, and sulphur 0.015 per cent.

It is interesting to note that a series of comparative tests on the case-hardening power of various gases, the results of which were communicated by J. C. Olsen and John S. Weiffenback at the recent Brooklyn meeting of the American Institute of Chemical Engineers, have shown that the case-hardening effect of carbon monoxide is greater than that of acetylene or methane. M. Charpy mentions that the carbon monoxide process has been applied to commercial case-hardening, and that a patent covering it has recently been taken out in France.

THE ILLUMINATION OF STREETS.

A COMPARATIVE STUDY OF THE VARIOUS SYSTEMS OF EXTERIOR ELECTRICAL ILLUMINATION.

C. E. Stephens—The Electric Journal.

THE general problem of efficiency in illumination, and the efficiency of modern light sources for interior lighting, particularly of industrial and manufacturing buildings, have been discussed at length in the two preceding numbers of THE ENGINEERING MAGAZINE. We return to the subject of illumination to present a brief review of an interesting comparative study of the various systems of exterior electric lighting, contributed by Mr. C. E. Stephens to *The Electric Journal* for June.

The problem in street lighting is to produce a uniform illumination of low intensity. To attain this result the light flux must be distributed in a particular manner. When the height of the lamp and the distance between lamps is considered, that source of light is preferred which gives most of the light flux between the horizontal and 25 degrees below the horizontal. For the sake of economy it is, of course, desirable to select a lamp whose initial distribution of light flux is as near the desired value as possible, that the use of reflectors may be avoided.

A correct theoretical arrangement of light sources to produce uniform illumination does not necessarily mean a satisfactory illumination. The results must

be judged in all cases by the effects produced. The light sources must be so arranged that the eye of the observer will not be exposed to their direct rays. Theoretically, therefore, more satisfactory street illumination can be obtained by decreasing the brilliancy of the light unit and placing it as high as practicable. Decreasing the brilliancy of light units ordinarily means that a greater number of lamps must be used. By spacing small candle power lamps near together, more uniform distribution of light can be obtained; the cost of installation and maintenance, however, determines to a large extent the size of the illuminating unit.

"A source of light giving an ideal distribution for street illumination is one producing no light in the upper hemisphere, whose maximum candle power is as an angle approximately 15 degrees below the horizontal and whose minimum candle power in the lower hemisphere is directly beneath the lamp. Such a distribution makes it possible to hang the lamp high, raising the arc above the direct line of vision, thus eliminating the glare in the eyes of people on the street, and at the same time maintaining a more nearly uniform illumination of the street. Furthermore, in hanging the lamp high, the shadows of objects along the street are shortened, the illumination directly under the lamp is reduced appreciably and the eye fatigue eliminated in that it then becomes unnecessary for the eye to adjust itself for the alternate bright and dark spots."

In present practice the comparison of light sources is based on the candle power and the curve of light distribution. "The typical shape of the light-distribution curve for a direct-current open arc shows that the maximum light is radiated at an angle of approximately 45 degrees below the horizontal. The light is emitted from the incandescent crater of the positive carbon, which accounts for the direction of the maximum candle power. Very little light is emitted from the short non-luminous arc, and the light intensity near the horizontal is comparatively small. The use of this type of lamp for street service is very objectionable on account of the fact that it is almost impossible to approach a uniform illumination of the street. It produces a very disagreeable and dancing shadow immediately under the lamp, and an intensely illuminated area a short distance from the lamp, beyond which point there is comparatively no light.

"The light-distribution curve of an alternating-current open arc is approximately the same above and below the horizontal. The light radiated above the horizontal is useless for all practical purposes unless suitable reflectors are used to deflect it downwards. It is not practicable to design a reflector which will operate at a maximum efficiency with all positions of the arc throughout the life of a pair of carbons. Furthermore, there is always a loss in the reflection depending upon the material used for the reflector. It is apparent that the alternating-current open arc for a street illuminant is inferior to the direct-current open arc.

"The development of the enclosed carbon arc resulted in a great operating economy, since the life of the carbon and the saving of labor in trimming and caring for the lamps was greatly increased. On account of the fact that in an enclosed arc the ends of the carbons are flat and have a comparatively large area, the crater can only occupy a small portion of this area at a particular instant. The distribution curve is consequently very irregular, since the amount of light in a given direction varies with the position of the crater on the end of the carbon. In general, the effect of this wandering arc can be eliminated to a great extent by the use of an opal enclosing globe which not only steadies the illumination, but decreases the intrinsic brilliancy of the arc. The development of the enclosed carbon arc was a decided advance regardless of the fact that the efficiency of the lamp as a light producer was considerably reduced. The energy consumption is the same as for the open arc, the total light flux is somewhat less, but the curve of light distribution is considerably superior to that of the open carbon arc.

"During the last few years we have been going back to the open-arc prin-

ciple to a very marked degree. Arc lamps have been developed which use the so-called flame carbon. Lamps of this type produce large quantities of fumes and smoke, to dispose of which necessitates an open-burning condition. The maximum light intensity is emitted directly under the lamp, and it is quite impossible to produce a uniform illumination over a large area. Furthermore, owing to the short life of the carbons, the care and attention required is very large and the consequent high maintenance cost prohibits its use as a street lamp.

"More recently there has been developed a type of arc lamp which consumes metallic electrodes. This lamp is of the flame type in that it has an open-burning condition and the light emitted comes almost entirely from the luminous flame. The color of the light is almost pure white, which has been found to be the ideal light for such low illumination intensities as are found in average street lighting. Since the larger portion of the light comes from the flame, it is radiated near the horizontal, very little above the horizontal, and has a comparatively low value immediately under the lamp. The maintenance cost of this lamp compares very favorably with that of the enclosed carbon arc, and altogether it is the most important development resulting from experiments having as their object an arc lamp of high efficiency with an almost ideal curve of light distribution for street illumination.

"Incandescent series lamps can be used very successfully in cases where the results obtained are to be at a minimum expense, and where the conditions will not permit the use of high candlepower units of the arc type. The service requirements of a series system of incandescent street lamps are an efficient series lamp, an efficient and satisfactory device for automatically regulating the current, and some automatic device for cutting out a lamp when the filament breaks.

"The recently developed tungsten incandescent series lamps are a great improvement over the low-efficiency carbon-filament lamps. The lamps are furnished in various candle powers from 25 to 80 and give an average life of from 1,200 to 1,800 hours in commercial service. They show but little reduction of candle power during their normal life, the quality of the light remaining excellent, and the filament does not become yellow. There are in general use today two systems of series tungsten lighting, the choice of which depends on the local conditions and to some extent upon the number of lamps to be installed. These are known as the 'adjuster socket' and 'regulator' systems.

"The adjuster socket system consists of a series of lamps connected across the high tension alternating-current mains with an impedance coil connected in shunt to each lamp for maintaining the continuity of the current when a lamp burns out. The ampere capacity of all the lamps in one series must be the same and the sum of the voltages of the lamps must equal the voltage of the circuit to which they are connected. The regulator system differs from the adjuster socket system in that the series of lamps is controlled by a constant-current regulating transformer which automatically controls the current of the circuit. With this system each lamp is furnished with a socket, the clips of which are insulated with a suitable insulating film, which will withstand the voltage of the lamp. When the lamp filament breaks the full voltage of the regulator is impressed on the insulating film which is punctured, thus short circuiting the lamp and closing the circuit again.

"In this connection it might be well to mention that considerable improvement has been made in the reflectors used with series incandescent lamps by which the effective illumination has been materially improved. The series incandescent lamp does not come into competition with the arc light which is required for different conditions of service. Its field of application is in outlying districts, parks, densely shaded areas, etc. It is in direct competition with gas lamps, and it has been thoroughly demonstrated that it is far superior on the basis of cost for equivalent illumination, efficiency of light distribution and ease of installation and maintenance."

FUEL FROM PEAT.

A PROCESS FOR CONVERTING PEAT INTO FUEL WITHOUT AIR DRYING.

Dr. Martin Ekenberg—Iron and Steel Institute.

IN the September, 1908, number of THE ENGINEERING MAGAZINE we referred briefly in these columns to a new process for the conversion of raw peat into fuel, invented by Dr. Martin Ekenberg. The treatment described was based on the discovery that after heating the peat in the presence of water to a temperature of at least 150 degrees C., about 90 per cent of the contained water, which under ordinary conditions resists separation by mechanical means, can be removed by very moderate pressure. A water-free fuel can then be obtained by the application of a small amount of artificial heat. Dr. Ekenberg has recently given before the Iron and Steel Institute an explanation of the changes produced in the peat by "wet carbonising," and an account of the extended researches he has made in applying his discovery to a commercial process. We take a few additional data from his paper, which is published in full in the *Iron and Coal Trades Review* for May 14.

Dr. Ekenberg's experiments led to the discovery that the water fails to separate under pressure because of the presence in mature peat of 0.2 to 1.2 per cent of a slimy hydrocellulose, produced by long contact with water of the cellulose in the residues of the decaying plants of which mature peat consists. The greater the percentage present, the more difficult it becomes to separate the water. The hydrocellulose is enormously swollen, having taken up water and formed a jelly of the consistency of soft soap. A pulp from mature peat behaves exactly as a jelly when subjected to pressure; it will, for instance, pass unchanged through the meshes of ordinary canvas with holes of about one square millimetre. If, however, the hydrocellulose be extracted or destroyed, the bulk of the water in the peat pulp can easily be separated from the plant residues by very moderate pressure. It was found that the hydrocellulose readily forms dextrose and is destroyed by heating in the presence of water to temperatures above 150 degrees C. After this discovery there was little difficulty in devising a treatment by which the separation of water could be technically effected.

In contradistinction to the process of ordinary dry charring in retorts, Dr. Ekenberg describes his process as one of "wet carbonisation"; the heating medium is superheated liquid water, and the percentage of carbon in the peat gradually increases with rise in temperature, owing to the combination of some of the oxygen and hydrogen in the peat to form water. The factors influencing the various stages of the process he discusses in detail and presents many experimental data to support his conclusions. "The results obtained from the researches and experiments show beyond doubt that by previously heating the peat to a certain temperature the bulk of the water can be mechanically expelled at low pressure. Moreover, they show that this treatment equalizes the different kinds of peat, converting all peat, young and mature, into a product of uniform properties and fuel value. As a basis for a commercial process, this treatment has the advantage of not requiring outside raw materials. The heat and power required can be produced by a part of the peat itself making manufacture independent of weather and season. The carbonisation is instantaneous, and the time required for making fuel from the raw peat is only that required for heating, cooling and pressing. The pressing can be done within a minute, and the heating and cooling ought not to require more time than the heating and cooling of water, provided an efficient apparatus is used. Air drying occupies one to three months. With suitable mechanical arrangements the wet-carbonising process ought not to take more than thirty minutes in all.

"How much heat and power, respectively, will the process require? To heat the peat up to, say, 200 degrees C., no

more than 200 calories per kilogramme need be used. The specific heat of the peat pulp is 0.92 or, say, 1. As free or sensible heat can be regenerated, the net cost of the heating ought only to be a part of the 200 calories required to reach the desired carbonising temperature. The heated pulp can be cooled by the raw pulp awaiting its turn to be heated, and thus great saving of heat obtained." Large-scale experiments conducted by Dr. Ekenberg have demonstrated the possibility of regenerating as much as 65 per cent of the heat applied.

Assuming the calorific value of mature fuel peat as 5,600 calories per kilogramme, the heat balance of the wet-carbonising process shows that about 14.3 per cent of the peat in the pulp has to be sacrificed in the wet-carbonising oven. The cost of the fuel in the process equals practically only the expense of its excavation and transport to the factory. Assuming that one-seventh of the original water in the peat is left in the press cakes, or 1 pound of moisture for each pound of peat, an additional 14.3 per cent of the peat in the pulp has to be used to produce an absolutely water-free fuel. It is possible, however, to carry out the drying partly with waste heat from other parts of the factory, the carbonising oven and the power plant; in this way 25 to 30 per cent can be saved. For expelling the water, any press capable of working at 50 atmospheres can be used; with gasified fuel and gas engines the power required is equivalent to a consumption of 1½ per cent of the peat, all transformation losses included. From the water-free, wet-carbonised peat a compresesd fuel with a heating value of about 6,200 calories or 11,000 B. t. u. per pound can be obtained in a briquetting plant such as is widely used in many parts of Europe for the manufacture of lignite briquettes. The output of the briquetting press commonly used is about 50 tons per twenty-four hours. The cost of power, heat and labor for briquetting are well-known items, and when all heat and power required for excavation, transport, pulping, pumping, carbonising, pressing, final drying, and briquetting are estimated, the conclusion may be arrived at that the total fuel consumption in making briquettes from the wet carbonised peat will equal 37 per cent of the fuel available in the raw peat. Based on a price of £20 per acre of peat bog of average depth, Mr. C. Dellwik has given an estimate of 6s. 8d. as the total cost per ton of peat briquettes.

Considering the high fuel consumption in the factory, the question of the possible recovery of by-products becomes of importance. This also has been investigated by Dr. Ekenberg. The recovery of nitrogen in ammonium sulphate from that part of the peat which has to be used as fuel in the manufacture of wet-carbonised peat is to be looked upon as a sound proposal. It considerably increases the percentage of fuel required, from 37 to 45 per cent, but if an average peat is worked, that fuel is paid for by the sulphate produced. Peat always contains nitrogen, the percentage of which varies from 0.6 to 2.8 per cent, the average being 1.1 to 1.5 per cent. If the cost of manufacturing the briquettes from an average fuel be computed upon the basis of gasified fuel and ammonia recovery, it will be found to be only 4s. per ton.

The appearance of a briquette of wet-carbonised peat is very similar to that of a lignite briquette. It has a glossy black surface and is very hard. During the wet-carbonising process a wax of paraffinous nature is liberated, which serves as a binder for the particles. The amount of wax formed is about 3 to 4 per cent. For all practical purposes the briquettes can be regarded as impervious to water. They burn with a long luminous flame and are quickly lighted. With an ordinary chimney draft they burn without soot or smoke. The percentage of ash is about 3.8, and of moisture 3 to 4. The specific gravity of the wet-carbonised peat briquettes varies from 1.29 to 1.35. Owing to their regular shape their volume weight is much higher than in the case of coal. Bulk for bulk, there is no difference in the heating value of the briquettes and ordinary coal. Sudden heating and cooling do not disintegrate briquettes of wet-carbonised peat. They can be burned under locomotive boilers with-

out any change being made in the construction of the fireboxes or grates. In a recent locomotive trial run at full speed, wet-carbonized peat briquettes produced 6.2 pounds of steam at about 130 pounds pressure per pound of fuel. In the same locomotive ordinary coal generated 6.7 pounds of steam per pound of fuel under similar conditions.

Dr. Ekenberg has made a few experiments on the coking of peat. While tests on a commercial scale have not been attempted, he has demonstrated in the laboratory that an excellent metallurgical coke can be made from wet-carbonised peat briquettes. In the manufacture of illuminating gas also, peat briquettes, on account of their freedom from sulphur, will have a wide application. In yield of gas 2 tons of wet-carbonised peat is equal to 3 tons of best gas coal, and the by-product charcoal will fetch higher prices than the ordinary gas coke.

THE MANUFACTURE OF NITRATES FROM THE ATMOSPHERE.

A DESCRIPTION OF THE BIRKELAND-EYDE PROCESS FOR THE FIXATION OF ATMOSPHERIC NITROGEN.

Sam Eyde—Royal Society of Arts.

WE have followed more or less closely in these columns the development of processes for the fixation of atmospheric nitrogen. The most recent, the Frank-Caro process for the production of calcium cyanimide, was described at length in August of last year. About three years ago the manufacture of nitrates from the atmosphere by the process invented by Birkeland and Eyde was reviewed in detail. In the six years since the first experiments on a commercial scale were made, the artificial nitrates industry in Norway has had a remarkable development. The apparatus has grown from small furnaces which could be held in the hand and which took only a few kilowatts of electrical energy, to furnaces of 1,500 horse power; and from absorption apparatus of glass of a few litres capacity to granite towers with a capacity of 600 cubic metres each. The power requirements of the expanding plant have necessitated successive removals from Frognerkilens, where the first experiments were made in 1903, to Ankerlökken, to Vasmoen, and finally to Notodden. Three miles from the latter, at Svælgfos, the Norwegian Nitrogen Products Company has erected the largest hydro-electric plant in Europe, to serve the nitrate factories. An authoritative account of the present methods and apparatus used in the manufacture of nitrates from the atmosphere was recently communicated by Herr Sam Eyde to the Royal Society of Arts. We abstract the following details from the *Journal* of the Society for May 28.

The chief difference between the Birkeland-Eyde process and the processes of their predecessors lay in the application of large instead of small quantities of energy in the electric arc. With the discovery that the old belief that small quantities of energy gave relatively the best results was erroneous, the whole theory of atmospheric combustion was revolutionised; with the determination of the most suitable electrical conditions of application and the invention of a suitable type of furnace, the synthetical nitrate industry was created. The nitrogen of the air is oxidised in the electric furnace by means of an arc formed between two water-cooled electrodes, the points of which are placed close to each other. An easily moveable and flexible current is thus established, which is made to pass through a highly magnetised field. The magnetic field causes the electric arc to move with great velocity perpendicularly to the lines of force, and the foot of the arc draws back from the points of the electrodes. Increase in the length of the arc causes an increase in the resistance and in the tension, until at length the latter becomes so great that a new electric arc starts from the points of the electrodes. To regulate the current an inductive resistance is used in series with the flame. With alternating

current all the arcs are formed in opposite directions and appear to the eye to be circular discs. These disc flames burn with astonishing steadiness. Over 1,500 horse power can be applied to electrodes of copper tubing, 1.5 centimetres thick, for the production of a flame 1.8 metres in diameter. The flame is produced in a circular chamber only a few centimetres wide and about 2 metres in diameter. After the oxide of nitrogen is formed in the furnace, it is converted in the oxidation tank into nitrogen dioxide, and in the absorption towers into nitric acid.

The furnace house at Notodden is a steel and masonry structure, with a floor space of about 2,000 square metres. In the basement are tubes for admitting the air and others for carrying off the gas. Of the 36 furnaces installed, 32 receive their power from Svælgfos and 4 from the Tinfos station. The current, which is carried on 18 12-millimetre copper wires, passes through oil-cooled transformers immediately after it enters the furnace house. For the regulation of the energy supply to the furnaces, each is furnished with an induction coil.

The air is conveyed to the flame through the fire-brick walls of the flame chamber. The nitrous gases formed in the flame escape through a channel made along the casing of the furnace which, like the flame chamber, is lined with fire brick. The furnaces burn for weeks with practically no regulation, and the maintenance and repair charges are very low. The electrodes have to be replaced only every third or fourth week, and the fire-brick linings every fourth to sixth month. The walls of the furnaces are of cast steel and iron; the middle is built out into a circular flame chamber into which the electrodes enter radially. Air is drawn in through tubes in the basement by centrifugal fans. The temperature of the flame is from 3,000 to 3,500 degrees C., and the temperature of the escaping gases 800 to 1,000 degrees C.

A part of the heat in the escaping gases is recovered by passing the gases under four steam boilers in a separate building, to which, after escaping through the casing of the furnace, the gases are led through two collecting pipes about 2 metres in diameter. As will be noted later, the steam produced is used in the further treatment of the products. Part of the remaining heat is used for concentrating the products and, in winter, for warming the buildings. The gases are finally cooled in apparatus consisting of a large number of aluminium tubes, over which cold water runs and through which the hot gases pass. From the cooling chambers the gases are led to the oxidation tanks.

"These oxidation tanks are vertical iron cylinders, lined with acid proof stone. The object is to give the cooled gases a sufficient period of repose, in which the oxidation of the oxide of nitrogen may have time to take place. The necessary amount of oxygen is present in ample quantity in the air which accompanies the gases from the furnaces. From the oxidation tanks, the gases are led into the absorption towers. All the towers are filled with broken quartz, which is neither affected by nitrous gases, nor by nitric acid. To assist the passage of the gases on their way from the furnaces, there are centrifugal fans, constructed of aluminium, on each row of towers.

"The gases enter at the base of the first tower, go up through the quartz packing and thence by a large earthenware pipe enter the top of another tower, through which they pass downwards through the quartz to the bottom of the third tower, and so on, until the air, relieved of all nitrous gases, leaves the last tower. Water trickles through the granite towers and this is gradually converted into a weak nitric acid, while the liquid used in the wooden towers is a solution of soda. The absorbing liquid enters the top of the tower and is distributed in jets by a series of earthenware pipes, so that the permeating gases come in immediate contact with the absorbing liquid. In the granite towers nitric acid is thus formed, and in the wooden towers a solution of nitrate of soda.

"The liquid emerges in a constant, even stream from the bottom of the towers, that from the granite towers

running into a granite cistern. Hence it flows into the 'montejus' which serve to pump up the acid, which has to pass repeatedly through the tower before it has become strong enough for the purpose for which it is intended. The 'montejus' are of stoneware strengthened with iron shields, are worked by compressed air, and send the acid up into large stoneware jars. From these jars the acid again runs through the towers as described. The 'montejus' work automatically. The wooden towers are percolated, as already mentioned, by a solution of soda, otherwise the whole process is practically similar to that in the granite towers. The solution of soda, owing to its far greater power of absorption, effects the separation of the last remains of nitrogenous gases from the accompanying air. Of the entire quantity of nitrous gases passed through the absorption system, about 97 per cent is absorbed. The finished nitric acid coming from the towers, which has a strength of about 30 per cent by volume, is collected in granite cisterns, from which it is drawn to what is called the 'dissolution works.' These consist of granite vats filled with limestone, over which the acid is poured. This drives off, with violent effervescence, the carbonic acid contained in the limestone, while the nitric acid takes its place and forms a watery solution of nitrate of lime or calcium nitrate. This solution of nitrate of lime is now pumped into vacuum evaporating apparatus. The object of boiling in vacuum is the well-known fact that great saving is thereby effected in the heat required.

"The steam required for the evaporisation is obtained from the steam boilers, heated, as before mentioned, by furnace gases. The concentration of the nitrate solution in the evaporising plant is continued until the specific weight of the liquid at a given temperature shows a content of 13 per cent of nitrogen. This solution is then sufficiently evaporated, and can be pumped up into the solidification chambers. These are fitted with shallow iron pans, under which cold air is pumped to accelerate cooling. After some time, the nitrate stiffens into a brittle, crystalline mass, hard as stone. This is broken up into lumps, and is taken into the crushing machines. These consist of ball crushing mills, which reduce the mass to a granular state. The coarse powder so produced is raised by elevator to a vat, from the bottom of which it is tapped into casks holding 100 kilos net weight.

"It now remains only to mention the further treatment of the nitrite formed in the alkaline towers. When this is pumped away from the towers, it contains, besides nitrite and water, also some nitrate of soda, and bi-carbonate. The further process is designed to separate the pure nitrite from the other substances. This is accomplished by first boiling away some of the water, which is done, as in the case of the nitrate solution, by steam from the steam boilers, heated by the furnace gases. The nitrite solution, concentrated to a suitable boiling state, is run into crystallisation pans, in which the crystallisation of the nitrite takes place. The crystals are separated by centrifugal means and are conveyed by a screw transporter to a drying apparatus, where they are subjected to a current of hot air. The finished product is then run into casks containing 300 kilos each. These are likewise made in our own shops. This nitrite of soda is used as the raw material in the manufacture of certain kinds of aniline colours. The manufacture of nitrite is carried on in a separate building.

"In the entire process of manufacture, both of nitrite and nitrate, no coal is used; all the machinery is worked by electric power, and, for heating and evaporating the nitrate and nitrite solutions, the only steam employed is that obtained by the hot gases passing through a system of steam boilers.

"We are, moreover, in our industry, not confined to the two products hitherto mentioned, nitrate of lime and nitrite of soda. We have possibilities for the development of a whole series of new industries, of which I will specially name the production of nitric acid, nitrate of ammonia, nitrate of potassium,

and others. We have succeeded, in conjunction with the Nobel (nitro-glycerine, etc.) Syndicate, in concentrating our weak acids, by means of gases from our furnaces, to acids of a high percentage which can be transported."

Herr Eyde's paper is concluded with a discussion of the highly satisfactory results of the use of nitrate of lime as a fertiliser in competition with nitrate of soda, and a brief description of the Svælgfos power station.

ELECTRO-CHEMICAL PLATE AMALGAMATION.

THE LATEST APPLICATION OF ELECTRICITY TO THE METALLURGY OF GOLD.

Elmer E. Carey—The Mining Journal.

THAT the application of electricity has the effect of hastening and intensifying the action of mercury and cyanide in the metallurgy of gold, has long since been demonstrated in the laboratory. It is only within the last ten years, however, that progress has been made in the practical development of electro-chemical processes applicable to this field. The cyanide process was the first to receive attention; electro-cyaniding has now attained to a position of considerable importance. More recently electro-chemical action has been applied to plate amalgamation, according to Elmer E. Carey, who describes the process in *The Mining Journal* for June 12, with highly satisfactory results.

"The electro-chemical system of amalgamation is designed to extract from the sands or pulp all gold values not encased. It is entirely a new system of amalgamation, designed to do the work of the ordinary mill plate, including the treatment of slimes, and, at the same time, to extract values which cannot be saved by the usual mill practice, and which otherwise would require cyanide treatment; to do all this in one single, inexpensive and continuous operation, requiring practically no more outlay for installation and maintenance than the usual mill plate. The system also furnishes a method by which the Alaska beach deposits, black sands, hydraulic, placer and dredge tailings, mill tailings, desert deposits and many low grade propositions can all be profitably worked.

"It may be sometimes necessary to grind ore or sands to 100, 150 or even 200 mesh before the values are released, but after this has been done the pulp is simply passed over the amalgamating device, and the electro-chemical forces automatically extract the values to such an extent that usually no further treatment is profitable. In ordinary cases values are recovered at 80 mesh. In certain cases where the ore is unusually refractory, base or complex, it may be necessary to treat the tailings for an hour or two by the continuous electro-cyanide process, which is an exceedingly simple and inexpensive operation, but withal very efficient.

"The electrolytic method of amalgamating calls for a sluice box of suitable width, the length being 40 or 50 feet, or even longer, according to conditions. In the bottom of the box is an ordinary copper plate acting as a cathode. Graphite anodes of suitable construction are arranged to conduct the low voltage curent into the water (electrolyte) passing over the device. Pulp of proper fineness, screened gravel or sand, is passed into the apparatus by suitable means. Certain solutions are also added to the water. A critical low voltage current of proper amperage is passed into the anodes; the water, carrying pulp, etc., acts as an electrolyte, and makes the electric connection with the copper plate (cathode). In operation, the water is at all times electrified, and the copper plate is also constantly under electrical action. The device can be made of any desired capacity."

The current density used is about five-tenths ampere per square foot of cathode surface; the pressure at the generator is from 5 to 10 volts. The solutions added to the water contain mercury and sodium salts and some salt from which hydrogen is easily liberated by electrolytic

action. The mercury solution is added to the water passing into the apparatus, the amount depending on the values in the pulp. About the same amount of metallic mercury as is used in ordinary amalgamation practice is necessary; practically all of it is recovered in the amalgam.

Several chemical, electrical and electro-chemical processes are in constant operation in the amalgamation box, the reactions which would ordinarily occur being greatly intensified by the presence of the electric current. The most important part of the process is the even, constant and uniform deposition of mercury on the cathode plate by the electrolysis of the mercuric solution. The coating of mercury is chemically pure, it adheres tenaciously to the plate and has no tendency to "flour." As the mercury is liberated in its nascent state, its affinity for metals and gases is much greater than in ordinary practice; its amalgam-forming powers are intensified to such a degree that rusty, greasy or pyritic gold is readily amlagamated. "Fouling" or "sickening" of the plate is impossible.

Fouling of the plates is prevented by the liberation of nascent hydrogen, the cleansing and reducing powers of which are used to great advantage in electro-chemical amalgamation. It destroys instantly organic, greasy and foul conditions, counteracts all impurities in the water, and cleans rusty gold. Large quantities of hydrogen are occluded in the mercury as the latter is deposited and exercise continuously a powerful cleaning and reducing effect.

Metallic sodium, liberated from the sodium salt, unites with the mercury to form sodium amalgam. The conditions of its formation ensure its purity. With the hydrogen occluded in the mercury it forms hydrogen-sodium amalgam, the most powerful amalgamating agent known. Hydrogen-sodium amalgam, besides holding free gold in any condition, will also hold platinum. It will amalgamate all metals not encased, which are in a comminuted state. Amalgamation takes place as soon as a particle of gold touches the quickened mercury surface; the larger particles will come in contact with the mercury very soon after entering the sluice box; microscopic values will require possibly 40, 50 or even 60 feet of cathode surface. Experiment has demonstrated that electrolytic amalgamation will recover from 95 to 99 per cent of all gold not encased, and in many cases the extraction reaches 100 per cent. Usually when the pulp of refractory ores is ground to 100 to 200 mesh, the tailings, after passing the electric amalgamator, do not contain enough values to make supplementary gold-saving devices necessary.

A COMPARISON OF COAL-CUTTING MACHINES.

A DISCUSSION OF THE APPARATUS, METHODS AND COST OF MACHINE MINING IN GREAT BRITAIN.

Sydney F. Walker—Engineering and Mining Journal.

ONE of the means most frequently urged for the reduction of the enormous waste in American coal mining is the adoption on a more general scale of coal cutting by machine, in the place of present methods of extraction by the use of explosives. British practice in machine mining is discussed at length by Mr. Sydney F. Walker in *The Engineering and Mining Journal* for May 22. We abstract from his paper a few notes on the apparatus, methods and economy of mechanical coal-cutting in the United Kingdom.

"The operation of the four principal types of machines, the puncher, the disk, the bar and the chain, are distinctly different though all are aiming at the same result, to imitate the work of holing done by hand labor in the past, and if possible to improve it. The puncher machine in the original form, consisting of the drill with its air cylinder behind it, carried on a pair of wheels, appears to answer more nearly to the work of hand holing than any of the others. Strictly speaking, the puncher is a pick, with a power machine behind it, wielded by the

runner, and it has nearly all the flexibility of the hand pick.

"Whenever a machine is arranged to take the place of hand labor, the machine is always at the disadvantage that it has not the flexibility of hand work. In the case of holing under the coal for instance, the skilled miner could work around balls of pyrites, and could literally pick his way, on the line of least resistance. The puncher machine arranged with its wheel carriage, is able to closely follow this. On the other hand, the bar and the disk and the chain all have to cut more or less uniformly and more or less blindly. There is no flexibility about them, except as will be described below. The action of these three again is different.

"The cutting tools of the disk machine remove the dirt, or the coal, whichever they may be cutting in, by scraping. It is more or less the action of a carpenter's chisel. The bar machine with its reciprocating and rotary motion, claims that its action is that of the pick, but the work is divided up among a large number of very small picks. In the chain machine it is claimed by the makers, that the action of the cutting tool is closely similar to that of the pick, and the material brought out by the cutters bears this out to a large extent in a great many instances. With the disk and bar machines, the holing dirt is usually dust, with the chain-jib machine the holing substance is brought out in small lumps.

"The bar machine has claimed an advantage over the disk, that in case of the coal settling down upon the machine, the friction is nothing like as great, and the bar could go on working, while the disk might have to be stopped; this is evidently correct. Both the bar and the chain machines have the great advantage that the coal can be spragged right up to within a few inches of the cutting tool itself, while in the case of the disk the spragging of course has to be some distance behind the disk itself. Further, the chain machine appears to have a distinct advantage in the fact that the plates between which the rollers upon which the chain-runs are held, does not move in the same sense as the disk moves. It moves on as the machine moves, and as the cut moves, but it is not in continual motion like the disk is, and therefore the friction is considerably reduced. This is borne out in practice by the fact that the chain machine works with approximately half the power of the disk machine for any given work.

"The bar machine also works with considerably less power than the disk machine, and approximately the power for chain and bar machines for the same work are about equal. By the same work is meant cutting in the same material, and to the same depth. It is understood of course that the power required for cutting in different materials, is different. The smallest power required is for cutting in soft kinds of coal, the largest for cutting in hard fireclay. Both the bar and the chain machines also have the advantage, which is now a thoroughly practical one, in the machine on the market, that they are able to avoid obstacles, such as the nodules of pyrites that are the *bête noir* of the coal-cutting machine. Both the bar and the chain are arranged to be inclined upward or downward, so as to avoid any piece of hard substance, and that without interfering with the general arrangement of the platform.

"All three forms, the bar, the chain, and the disk, are now arranged to cut at practically any level that is met with in a coal pit, and all of them are made practically for any thickness of seam. All of them also are made to run on wheels resting upon rails, that are laid in front of the coal face, or on skids, which make their own floor. The skids were originally introduced by the makers of the chain machines, but the makers of disk and bar machines quickly followed suit."

Within recent years important improvements have been made in the bar and puncher machines. In the latest form of the latter, the drill is held upon a vertical, extensible pillar fixed between floor and roof. The connection between the body of the machine and its support is practically a universal joint and the drill is arranged to sweep over an arc in any plane and at any desired angle. In spite of all improvements in

its competitors, however, the disk machine is still leading; as late as 1905 the number of disk machines in use still exceeded those of all the other types of machines together. For driving headings the punching machine is a keen rival of the chain header, but the latter seems to be holding its own.

"The cost of getting coal by the disk machine, which varies necessarily with the material cut in, and with the other conditions, ranges from 26c. per ton to $1.10, the latter being an exceptional price, 40 to 62c. being the general range. The saving with coal-cutting machines over hand labor, ranges from 2c. per ton up to 39c. per ton. In the majority of cases, the savings are from 8 to 16c. per ton. There does not appear to be any great difference between the costs when driving by compressed air and by electricity, under similar conditions. Further, the costs as obtained by impartial observers, appear to show that the disk machine is still the one working at the smallest cost all told, though again, with the same conditions, there does not appear to be any great difference. The question of the actual machine to be employed depends entirely, as in so many other engineering questions, upon the whole of the conditions present. Where the work to be done is heavy, it is at least wiser to use a disk machine, notwithstanding the disadvantages mentioned, while where the holing is light, one of the other machines may be employed with advantage.

"One important advantage that arises incidentally from the use of coal-cutting machines, is the increased output per man employed. In the United Kingdom, with the increasing output of coal, the number of skilled men available is becoming proportionately less, and therefore any increase in the output per man is of value, both from this cause, and also because it lessens the outlay for providing houses for the miners. . . .

"In 1900, by far the largest number of coal-cutting machines in use in the United Kingdom were driven by compressed air, the proportion between those driven by compressed air and by electricity being nearly as 5 to 1. But with the development of the use of electricity that has been going on so rapidly since then, the number of electrically driven machines has been steadily increasing. The number of coal cutting machines in use has increased from 316 in 1900, to 1133 in 1906, but the machines that have been brought into use since 1900 have been, a large number of them, electrically driven. In 1906 the proportion was 682 run by compressed air, and 451 by electricity. If the work the different machines are capable of doing is taken into consideration, the proportion would now be largely in favor of electricity, for among the machines run by compressed air, are a large number of the punchers of the 'Champion' and similar types. Recently, however, there has been a revulsion on the part of colliery managers against electric driving of coal-cutting machines, principally because of the greater danger to life. Electrical apparatus in mines in the United Kingdom, has unfortunately taken a somewhat large toll of life, and the toll has been particularly heavy in electrically driven coal-cutting machines."

The principal reason why electricity has been so largely introduced is the greater efficiency of transmission over compressed air. The power consumption of the coal-cutting machine is not a very important item in the total cost of machine mining, and in a great number of cases electricity does not present any great advantages, so far as economy in power generation is concerned, over compressed air. But the great objection to the use of compressed air has been the difficulty of maintaining pressure at the working face, and it is by offering a means of overcoming this disadvantage that electricity has made its appeal. Recent developments in compressed-air practice, however, among them the introduction of electrical machines for compressing air at the face and improvements in compressed air motors, with the tendency on the part of colliery managers to abandon the use of electricity because of the risk of accident, seem to indicate that compressed air is likely to recover some of its lost prestige as the motive power for coal-cutting machines.

THE ENGINEERING INDEX

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The following pages form a descriptive index to the important articles of permanent value published currently in about two-hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

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(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,
(7) *We supply the articles themselves, if desired.*

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The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

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Method of Constructing Concrete Abutments on Concrete Cylinders for a Skew Bridge Across the North Shore Channel of the Sanitary District of Chicago. Illustrated description of methods used in constructing an unusual substructure. 1800 w. Engng-Con—June 16, 1909. No. 5615.

Arches.

The Stability of Arches. Henry Adams. Read before the Civ. & Mech. Engrs. Soc. Discusses the conditions that must be fulfilled, giving a graphical method of determining stresses. 3000 w. Can Engr—May 28, 1909. No. 5156.

Determination of the Line of Resistance in Arches (Zur Berechnung des Stützliniengewölbes). Siegmund Schwätzer. Mathematical and theoretical. Ills. 7000 w. Oest Wochenschr f d Oeffent Baudienst—May 15, 1909. No. 5792 D.

Blackwell's Island.

Safety of the Queensboro Bridge. From the report of a commission of engineers to the Pennsylvania Steel Company. 2000 w. Ir Age—June 17, 1909. No. 5567.

Further Reports Upon the Blackwell's Island (Queensboro) Bridge Over the

We supply copies of these articles. See page 887.

East River. Reports concerning this structure, with editorial comment. 7000 w. Eng News—June 17, 1909. No. 5580.

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Foot Bridges.

Design of a Two-Span Foot Bridge (Berechnung eines Fussgängersteges von 2 Oeffnungen). R. Necker. Mathematical description of the design of elevated street crossings. Ills. Serial. 1st part. 1000 w. Elektrotech Rundschau—May 8, 1909. No. 5950 D.

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Masonry.

The Arciat Bridge (Note sur le Pont d'Arciat). M. Parent. Illustrated description of a masonry bridge over the Saône, of seven 31-metre spans. 3300 w. Ann d Ponts et Chaussées—1909-II. No. 5716 E + F.

Reinforced Concrete.

Computation of a Reinforced-Concrete Arch Rib with Fixed Ends for a Proposed 12th Street Bridge at Oakland, California. A. W. Miller. Mathematical discussion with diagrams. Ills. 9100 w. Engng-Contr—June 2, 1909. No. 5308.

The Galveston Causeway. F. E. Lister. Illustrated detailed description of a proposed concrete causeway to connect Galveston Island and the mainland. 2200 w. R. R. Age Gaz—June 11, 1909. No. 5471.

The Edmondson Avenue Bridge, Baltimore. A four-span concrete arch structure, carrying roadway and sidewalks, is illustrated and described. 1800 w. Eng Rec—June 19, 1909. No. 5623.

The Sinlumkaba (Burma) Ferro-Concrete Bridge. W. E. Haldwell. Describes methods adopted in constructing a reinforced-concrete arch. Ills. 3000 w. Soc of Engrs—June 7, 1909. No. 5663 N.

The Birkendorf Bridge Over the Feistritz (Die Feistritzbrücke in Birkendorf). Gustav Hermann. Describes and discusses the design of this reinforced-concrete arch. Mathematical. Plates. Ills. 5500 w. Oest Wochenschr f d Oeffent Baudienst—May 29, 1909. No. 5794 D.

See also Steel, under BRIDGES.

Steel.

Nickel Steel Eye-Bars. Editorial discussion of W. R. Webster's paper on "Nickel Steel Eye-Bars for Blackwell's Island Bridge," submitted to Am. Soc. of Civil Engineers. 1500 w. Eng Rec—June 5, 1909. No. 5276.

Steel and Reinforced Concrete Bridge Superstructures for the Bay Ridge Improvement of the Long Island Railroad James B. French. Gives general description of this work and the details mentioned. Ills. 7000 w. Pro Brooklyn Engrs' Club. No. 82—1908. No. 5873 F + F.

Some Features of the Bridges on the Harlem River Branch of the New York, New Haven and Hartford Railroad. Herbert C. Keith. Plans and description of bridges on a branch carrying a heavy freight business, and carrying the railway over many streets. Discussion. 9500 w. Pro Brooklyn Engrs' Club, No. 84—1908. No. 5875 F + F.

The Webster-Donora Bridge. Illustrated description of a highway bridge across the Monongahela River. 1500 w. Eng Rec—June 12, 1909. No. 5490.

The New Bridge Over the Wear. Illustrates and describes this double-deck road and railway bridge erected by the N.-E. Ry. Co., and the Sunderland Corporation. 1200 w. Engr, Lond—June 4, 1909. Serial. 1st part. No. 5536 A.

The Song-Ma Railway Bridge (Pont de Chemin de Fer sur le Song-Ma, Tonkin). Ch. Dantin. Illustrates and describes the construction of a bridge of novel design. 3000 w. Génie Civil—May 8, 1909. No. 5738 D.

Swing Bridges.

The Kaiser Wilhelm Bridge at Wilhelmshafen (Die Kaiser Wilhelm-Brücke in Wilhelmshafen). Karl Bernhard. Illustrated description of this interesting double swing structure. Serial. 1st part. 2700 w. Zeitschr d Ver Deutscher Ing—May 22, 1909. No. 5966 D.

Viaducts.

The Highland Boulevard Viaduct, Milwaukee. Illustrated description of a reinforced-concrete viaduct across a wide, deep ravine. 2200 w. Eng Rec—June 12, 1909. No. 5487.

Replacing the Cuyahoga Valley Viaduct, Cleveland, Ohio. Describes a new steel viaduct, and its erection. Ills. 3500 w. Eng Rec—June 5, 1909. No. 5286.

The Fades Viaduct Over the Sioule (Achèvement du Viaduc des Fades sur la Sioule). Describes a long, high, steel viaduct on the Puy-de-Dôme railway. Ills. 3000 w. Génie Civil—May 29, 1909. No. 5742 D.

CONSTRUCTION.

Beams.

The Calculation of Elastic Fixed and Continuous Beams with Variable Moment of Inertia (Ueber die Berechnung elastisch eingespannter und kontinuierliches Balken mit veränderlichem Trägheitsmoment). Max Ritter. Mathematical. Ills. Serial. 1st part. 2000 w. Schweiz Bau—May 1, 1909. No. 5766 B.

We supply copies of these articles. See page 887.

Coal Pockets.

Elevated Reinforced Concrete Coal Store. Illustrated description of a structure recently erected in Montreal. 1200 w. Engr, Lond—June 11, 1909. No. 5637 A.

Concrete.

Concrete in Water Works Construction. William Curtis Mabee. Principally an illustrated detailed description of the purification system of the Indianapolis Water Co. 4500 w. Am W-Wks Assn—June, 1909. No. 5922 N.

See also Conduits, under ELECTRICAL ENGINEERING, TRANSMISSION.

Concrete Blocks.

See Stacks, under CONSTRUCTION.

Contractors' Plants.

The Construction Plant for Covering the Providence Filters. Illustrated detailed description of the work and of the plant for executing it. 4500 w. Eng Rec—June 19, 1909. No. 5621.

Earthquake.

A Study of the Vibrations of the Earth's Crust Under Earthquake Shocks (Etude des Vibrations du Sol lors des Tremblements de Terre). M. J. Bergeron. A theoretical discussion. Ills. 6500 w. Mem Soc Ing Civ de France—March, 1909. No. 5703 G.

Earthquake Construction (Edilizia antisismica). Editorial discussion of various theories and suggestions. Ills. 3500 w. Il Cemento—May 15, 1909. No. 5745 D.

Construction for Earthquake Countries (La Construction en Pays de Tremblements de Terre). G. Espitallier. Discusses the applicability of timber, masonry, steel and concrete. Ills. 8000 w. Mem Soc Ing Civils de France—March, 1909. No. 5704 G.

A System of Architecture for Earthquake Countries (Système d'Architecture pour Sol agité ou mouvant). F. J. Pillet. Illustrates and describes a system of construction secure against earthquake shocks. 2300 w. Mem Soc Ing Civils de France—March, 1909. No. 5706 G.

Reinforced Concrete and Earthquakes (Le Béton armé et les Tremblements de Terre). G. Flament-Hennebique. A discussion of its use in structures in earthquake countries. 4000 w. Mem Soc Ing Civils de France—March, 1909. No. 5705 G.

Regulations of the Italian Government for the Construction and Repair of Buildings in Earthquake Districts. The text of the decree of April 18, 1909. Ills. 18000 w. Ing Ferro—May 8, 1909. No. 5746 D.

Factories.

The Design and Construction of Industrial Buildings. Herbert F. Stimpson. The first of three lectures before the senior class in mechanical engineering at Columbia University, N. Y. 6000 w. Eng Rec—May 29, 1909. Serial. 1st part. No. 5149.

Reinforced Concrete Construction in Industrial Plants. David Maxwell. Discusses the systems available 2500 w. Ind Engng—June, 1909. No. 5801 C.

Reinforced Concrete Industrial Buildings. J. P. H. Perry. Discusses questions in regard to the use of this material for manufacturing plants. 3500 w. Cement—May, 1909. No. 5557 C.

Fireproof.

Modern Fireproof Construction. Facts and Figures. W. N. Moorhouse. Discussion and comparison of types of construction for warehouses or factory buildings. Ills. and discussion. 6000 w. Can Soc of Civ Engrs, Bul. 5—May, 1909. No. 5852 N.

Fire-Resisting Construction at the New Temporary Crib for the 73d St. Water Tunnel at Chicago. Illustrated detailed description. 900 w. Eng News—June 17, 1909. No. 5578.

See also Reinforced Concrete, under CONSTRUCTION, and also under MATERIALS OF CONSTRUCTION.

Foundations.

The Foundations for the New City Hall in Chicago. Illustrated description of the methods of construction used in the foundation work of a 12-story building on unstable soil. 2000 w. Eng Rec—June 12, 1909. No. 5486.

Foundations of the Goldfield Consolidated Mill. Percy E. Barbour. Illustrates and describes a notable example of concrete foundations for mill construction. 1500 w. Eng & Min Jour—June 12, 1909. No. 5473.

Foundations and the Use of Concrete. Geo. W. Martin. Discusses concrete foundations for walls and engines. Ills. 2900 w. Elec Age—May, 1909. No. 5431.

The Calculation of Pile Foundations (Zur Berechnung von Pfahlrostgründungen). E. Jacoby. A mathematical discussion of load distribution, etc. Ills. 2000 w. Oest Wochenschr f d Oeffent Baudienst—May 29, 1909. No. 5795 D.

Grain Elevators.

Grain Handling in the United States. Sam'l O. Dunn. First instalment of a series discussing grain storage and transportation, including country and terminal elevators. 2200 w. R R Age Gaz—June 4, 1909. No. 5290.

Piling.

Discussion of Various Piles and Methods of Driving Them. Frederic W. Swain. An illustrated discussion of modern and various types of concrete piles. 2500 w. Harvard Engng Jour—June, 1909. No. 5991 D.

Earth Displacement in Pile Driving (Versuche über die Verdrängung des Bo-

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dens beim Einrammen von Pfählen). J. Ritter von Schoen. A report of test results. Ills. 2000 w. Oest Wochenschr f d Oeffent Baudienst—May 8, 1909. No. 5791 D.

Practical Dètermination of the Permissible Load for Piles (Praktische Anwendungen der Methoden zur Bestimmung der zulässigen Pfahlbelastung). Richard Kafka. Refers principally to the staticgeometric method. Ills. Serial. 1st part. 2200 w. Beton u Eisen—May 15, 1909. No. 5786 F.

See also Foundations, under BRIDGES.

Reinforced Concrete.

Reinforced Concrete House Built by an Entirely New Method. Describes a house built of steel tubing, wire, malleable fittings and concrete which shows radical departures from previous methods of fireproof construction. Ills. 1200 w. Ind Wld—June 7, 1909. No. 5386.

Ferro-Concrete Submarine Dêpôt at Haslar. Illustrates and describes a new dêpôt for submarine vessels built on the Mouchel-Hennebique system. 1500 w. Engng—June 11, 1909. No. 5660 A.

The Building and Equipment of the Keewatin Flour Mill. Illustrated description of a reinforced-concrete building in Ontario, its equipment and operation. 3000 w. Eng Rec—May 29, 1909. No. 5145.

Stresses due to Temperature Changes in Reinforced Concrete (Temperaturspannungen im Eisenbeton). Fritz v. Emperger. An examination of the magnitude of the stresses due to expansion and contraction. Ills. Serial. 1st part. 3000 w. Zeitschr d Oest Ing u Arch Ver—May 28, 1909. No. 5789 D.

See also Coal Pockets, Factories, Fireproof, and Retaining Walls, under CONSTRUCTION; and Reinforced Concrete, under MATERIALS OF CONSTRUCTION.

Retaining Walls.

A Reinforced-Concrete Retaining Wall Along the Bank of the Ohio River. Frank A. Bone. Illustrated description of a novel design constructed at Evansville, Ind. 600 w. Eng News—June 3, 1909. No. 5220.

Roofs.

Queen-Post Roof Trusses. Walter Hey and Thomas R. Sturgeon. Presents a solution of the stresses. 1500 w. Engng—June 11, 1909. No. 5657 A.

Stacks.

Reinforced Concrete Chimneys. Dr. Alfred Gradenwitz. Describes a chimney of concrete blocks erected in Belgium 125 feet in height. Ills. 900 w. Sci Am Sup—June 5, 1909. No. 5313.

Steel.

An Example of Defective Truss Construction. C. A. P. Turner. Illustrated discussion of dangerously defective structural steel frames. 1200 w. Eng News—June 17, 1909. No. 5576.

Methods of Designing Skew Connections in Complicated Steel Structures. Alexander Penden, Jr. Read at a students' meeting of the Can. Soc. of Civ. Engrs. Explains the way to determine such skew detailing, illustrating by actual connections. 2800 w. Engng-Con—June 9, 1909. No. 5353.

Steel work in the La Salle Hotel, Chicago. Description of structural-steel frame work of a 22-story building, 260 ft. in height and 180 by 180 in plan. Ills. 3000 w. Eng Rec—June 5, 1909. No. 5283.

The St. Paul Auditorium. Laurence A. Ball. Plans and description of the building, with discussion of its engineering features. 5000 w. Pro Brooklyn Engrs' Club, No. 85—1908. No. 5876 F + F.

See also Roofs, under CONSTRUCTION.

Tunnels.

East River Tunnel from South Ferry to Joralemon Street. Frederick C. Noble. Gives the history and illustrated general description of the tunnel and methods of construction. Discussion. Ills. 9000 w. Pro Brooklyn Engrs' Club, No. 80—1908. No. 5871 F + F.

MATERIALS OF CONSTRUCTION.

Cement.

Some Notes Relating to the Setting of Portland Cement, with Description of Methods Adopted for Regulating the same. H. K. C. Bamber. A résumé of results of research work. 3500 w. Archt, Lond—June 4, 1909. Serial. 1st part. No. 5512 A.

Paints.

Protective Coatings for Structural Material. R. S. Perry. Outlines scientific investigations in this field, and discusses properties of pigments, methods of testing, etc. Discussion. 10500 w. Jour W Soc of Engrs—June, 1909. No. 5879 D.

Reinforced Concrete.

A Hearing on Reinforced Concrete in the Revision of the New York Building Code. Gives extracts from the statements made at this hearing, in regard to reinforced concrete and cinder concrete. Also editorial. 5000 w. Eng News—June 10, 1909. No. 5463.

Compression Tests of the French Government Commission. Leon S. Moisseiff. Describes the compression tests on longitudinally reinforced columns. Ills. 2500 w. Cement—May, 1909. No. 5556 C.

Reinforced Concrete as a Fireproof Building Material. Leonard C. Wason. A paper presented before the Nat. Fire Protective Ass'n, which discusses the use of concrete and its fire-resisting properties. 2450 w. Engng-Contr—June 2, 1909. No. 5305.

We supply copies of these articles. See page 887.

The Strength of Thin Reinforced Concrete Columns (Sur la Résistance au Flambage des Poteaux en Béton armé). M. Mesnager. Results of tests. Ills. 5600 w. Ann d Ponts et Chaussées—1909-II. No. 5717 E + F.

Steel Preservation.

The Preservation of Iron and Steel. Allerton S. Cushman. Read before the I. and S. Inst. Examines the controlling factors that influence the causes and the cure of the corrosion of iron, and the possible bearing of the results of recent research. Also discussion. Ills. 17000 w. Ir & Coal Trds Rev—May 14, 1909. No. 5132 A.

Timber Preservation.

Wood Preservation. Report of Committee No. XVII of the American Railway Engineering and Maintenance of Way Association. 17000 w. Ills. Bul Int Ry Cong—May, 1909. No. 5684 G.

The Preservative Treatment of Timber (Traitement antiseptique des Bois). J. Vinsonneau. Describes the Nestor Marchal process for the treatment of soft, tropical woods. Ills. 2000 w. Rev Indus —May 1, 1909. No. 5735 D.

MEASUREMENT.

Cement Testing.

Testing the Compressive Strength of Portland Cement (Prüfung der Druckfestigkeit von Portlandzement). A. Martens. Describes apparatus and methods. Ills. 2000 w. Zeitschr d Ver Deutscher Ing—May 1, 1909. No. 5958 D.

Stream Gauging.

The Gauging of Streams by Notch-Boards. Detailed description of methods. 2200 w. Prac Engr—June 11, 1909. Serial. 1st part. No. 5627 A.

Surveying.

Phototopography, with Special Reference to the Alaskan Boundary. P. W. Greene. Describes the methods of photographic surveying and their applications. Ills. Discussion. 4500 w. Can Soc of Civ Engrs, Bul. 5—May, 1909. No. 5853 N.

Traverse Work in Connection with the Triangulation of the Borough of the Bronx with Special Reference to Accurate Measurement with Tapes. Edward H. Holden. Describes the triangulation and measurement of distances between stations. 4900 w. Engng Contr—June 2, 1909. No. 5310.

MUNICIPAL.

Drainage.

The Main Drainage of London. Abstract of a report prepared for the London County Council by Maurice Fitzmaurice, giving the history of drainage systems in London as early as the reign of Henry III. 1400 w. Engr—May 28, 1909. No. 5266 A.

Critical Canal Profiles (Kritische Kanalgefälle). Franz Schmidt. Discusses the design of drainage canals to prevent accumulations of sediment. Ills. 2300 w. Gesundheits-Ing—May 22, 1909. No. 5798 D.

The Formation of Sulphuric Acid in Nature and Some of its Effects on Drainage and Water Supply Problems (Bildung von Schwefelsäure in der Natur und einige Folgeerscheinungen namentlich auf dem Gebiete der Städteentwässerung und Wasserversorgung). Herr Bredtschneider. Discusses its effects on structural materials. Serial, 1st part. 7000 w. Gesundheits-Ing—May 1, 1909. No. 5796 D.

Malvern, England.

Works of a Municipal Nature in Malvern, Eng. William Osborne Thorp. Illustrates and describes the various undertakings. 6000 w. Surveyor—June 4, 1909. Serial. 1st part. No. 5514 A.

Roads.

The First International Road Congress at Paris in October, 1908; What Led Up to It; Its Deliberations; and Its Results. Austin B. Fletcher. Relates mostly to macadam roads and motor vehicles. Ills. 12500 w. Jour Assn of Engng Socs—April, 1909. No. 5841 C.

Extraordinary Traffic and Heavy Weights on Roads. W. H. Schofield. Read before the Road Conference. Discusses damage by heavy motor vehicles. Serial, 1st part. 2500 w. Surveyor—May 28, 1909. No. 5453 A.

Extraordinary Traffic in its Legal Aspect. W. Joynson-Hicks. Paper read before the Road Conference. Deals with heavy and motor traffic. 2400 w. Surveyor—May 28, 1909. No. 5452 A.

Concrete Roadways. Charles W. Ross. Second Prize article in contest of Ass'n of American Portland Cement Manufacturers. Describes the use of concrete in road-making, construction of curbing and sidewalks, bridges, walls, etc. Ills. 6000 w. Can Engr—June 4, 1909. No. 5390.

Instructions for Making Macadam Roads Without Steam Roller. A. N. Johnson. From Bul. No. 4, Ill. Highway Con. Directions for the work. 2500 w. Munic Engng—June, 1909. No. 5559 C.

Systematic Patching of Macadamized Roads with a Specially Designed Steam Roller and Water Tank. J. S. Pickering. Paper read at the Roads Conference which described a special roller and method. 1540 w. Engng-Contr—June 2, 1909. No. 5307.

Experiments on Bituminized Macadam Pavements. Deals with experiments made at Newton, Mass. 2500 w. Munic Engng —June, 1909. No. 5560 C.

Tar and Its Uses as a Dust Palliative. John Robinson. Deals with tar-spraying,

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tar-macadam, and tar-matrix. 2000 w. Surveyor—June 4, 1909. No. 5515 A.

The Great German Military Road and Boulevard. H. Prime Kieffer. Illustrated detailed description of the construction of this road, which will probably be the most beautiful in the world. 3000 w. Munic Engng—June, 1909. No. 5558 C.

Sewage Disposal.

Methods of Sewage Disposal. Alexander Potter. A brief discussion of the various systems used. 2500 w. Munic Engng—June, 1909. No. 5561 C.

A New Method of Treating Sewage. K. Imhoff. Illustrated description of method of sewage treatment used in Germany, in which deep tanks receive the sludge. 2500 w. Surveyor—May 21, 1909. No. 5189 A.

Sludge Disposal under Water and the Grimm Purification System (Klärschlammgewinnung unter Wasser und die Grimmsche Flachbecken - Kläranlage). Herr Mierisch. A criticism of Dr. Lübbert's paper, with reply by Dr. Lübbert. Ills. 2500 w. Gesundheits-Ing—May 29, 1909. No. 5799 D.

Special Features of the Travis Hydrolitic System of Sewage Tanks Being Constructed at Norwich. Arthur E. Collins. Read before the Royal Sanitary Institute. Describes the formation and elimination of matters deposited from sewage. 5100 w. Surveyor—May 28, 1909. No. 5451 A.

The Disinfection of Sewage. From the U. S. Geol. Survey paper No. 229, by Prof. Earle B. Phelps, discussing results of recent investigations. 2500 w. Eng. Rec—May 29, 1909. No. 5146.

Waterbury Sewage and Its Septic Action. William Gavin Taylor. Gives results of a comprehensive study of the characteristics of the sewage, its behavior under septic action, its purification, &c. 5000 w. Eng News—June 3, 1909. No. 5217.

Subsurface Distribution in Percolating Sewage Filters. Wm. Gavin Taylor. Describes tests made at the Waterbury, Conn., sewage disposal works. Ills. 2000 w. Eng Rec—June 5, 1909. No 5281.

Some Sewage Purification Problems in Wisconsin. G. J. Davis, Jr. States the present conditions and some of the problems needing solution. Ills. 2500 w. Wis Engr—June, 1909. No. 5693 D.

See also Harbor Pollution, under WATERWAYS AND HARBORS.

Sewers.

The Extension of the Glaise Creek Sewer in St. Louis. Illustrated detailed description of the construction. 2500 w. Eng Rec—June 12, 1909. No. 5488.

A Large Reinforced Concrete Sewer. Methods and costs of construction of a large section of sewer in the Northern part of St. Louis. 2300 w. Eng Rec—June 5, 1909. No. 5282.

Sewer Work in Louisville, Ky. Illustrated account of extensive work in progress, including an outfall sewer of reinforced concrete. 2000 w. Munic Jour & Engr—June 23, 1909. No. 5818.

The Sewerage System of Salt Lake City. L. H. Krebs. Plan and description of the separate system in use. 3500 w. Jour Assn of Engng Socs—April, 1909. No. 5842 C.

Sewer Trenches.

Comments on methods of Excavating Trenches and Ditches. First instalment of a series of articles which will discuss methods and costs. Ills. 2150 w. Engng-Contr—June 2, 1909. No. 5306.

Swimming Pool.

A Water Works Swimming Pool. Willis B. Durlin. Describes the public swimming pool at the pumping station in Erie, Pa. Ills. 1500 w. Pro Am W-Wks Assn—1908. No. 5949 N.

WATER SUPPLY.

Accounting.

Some Suggestions Relating to Uniformity in the Accounts, Financial Reports and Statistics of Water Works. Albert H. Wehr. 12000 w. Am W-Wks Assn—June, 1909. No. 5902 N.

Useful Uniform Accounts and Reports of Water-Supply Systems. L. G. Powers. A discussion of Mr. Wehr's paper. 3300 w. Am W-Wks Assn—June, 1909. No. 5924 N.

Aqueducts.

See Washington, D. C., under WATER SUPPLY.

Artesian Wells.

Artesian Waters of the Atlantic Coastal Plain. Myron L. Fuller. Illustrates and describes the geologic development, sources of artesian waters, their quality, temperature and related characteristics. 8000 w. Pro Am W-Wks Assn—1908. No. 5939 N.

Coolgardie.

Coolgardie (W. A.) Water Scheme. R. J. Vincent. Read before the Engrs' Assn., N. S. W. Illlustrated detailed description of the government water supply scheme. 4000 w. Aust Min Stand—May 19, 1909. Serial. 1st part. No. 5825 B.

Copenhagen.

Copenhagen Water Supply. William P. Mason. Illustrated description of a deep well supply. 700 w. Pro Am W-Wks Assn—1908. No. 5931 N.

Dams.

The Design of Emergency Movable Dams for Canal Locks. Letter from H. G. Tyrrell giving illustrations and description of the safety dams at Sault Ste. Marie. 1700 w. Eng News—June 24, 1909. No. 5867.

Turning the Colorado River and Completing the Laguna Dam, Arizona-Cali-

fornia. Edwin D. Vincent. Illustrated detailed description of the work of closing the Colorado River and the building of the sluiceways. 2500 w. Eng News—June 10,1909. No. 5459.

See also Reservoirs, under WATER SUPPLY.

Distribution.

Cheap Transportation and Delivery of Public Water Supply. H. C. Heermans. Gives a bulletin to consumers, issued by the company at Hoquiam, Washington, with remarks. 1500 w. Am W-Wks Assn—June, 1909. No. 5923 N.

Ditches.

The Vaucouleurs Regulating Trench of the Marne-Saône Canal (Rigole d'Alimentation du Canal de la Marne à la Saône dite de Vaucouleurs). MM. Suquet and Changey. Illustrated detailed description. 11500 w. Ann d Ponts et Chaussées—1909-II. No. 5714 E + F.

Filtration.

The Efficiency of the American Process of Water Filtration. James M. Caird. Illustrates and describes various plants, explaining methods by which the waters are treated and the results. 14000 w. Pro Am W-Wks Assn—1908. No. 5943 N.

Some Results Obtained by the Application of Hypochlorite of Lime on Mechanical and Slow Sand Filters and Method of Controlling Coagulant and the Operation of the Orifice Boxes. A. E. Walden. Ills. 1500 w. Am W-Wks Assn—June, 1909. No. 5909 N.

Rate Controller of the Cincinnati Filters. Illustrated description of this design, which is really a balanced valve for regulating the discharge. 2000 w. Eng Rec—June 19, 1909. No. 5622.

New Orleans Water Filtration Plant. J. W. Armstrong. Illustrated detailed description. 3500 w. Munic Jour & Engr—June 2, 1909. No. 5204.

The Cost of Five Slow Sand Filter Plants—Four small and one large. Data from installations at Ashland, Wis., Berwyn, Pa., Nyack, N. Y., Superior, Wis., and Washington, D. C. 3500 w. Engng-Contr—June 2, 1909. No. 5315.

See Contractors' Plants, under CONSTRUCTION; and Washington, D. C., under WATER SUPPLY.

Fire Protection.

Fire Protection for San Francisco. Gives details of the high-pressure system and of the 100 fire cisterns to provide against damage by earthquakes. Ills. 2500 w. Munic Jour & Engr—June 16, 1909. No. 5497.

Liability of Water Companies for Fire Losses. Chester R. McFarland. States cases where Kentucky, North Carolina and Florida held water companies liable. Also other cases. 3000 w. Am. W-Wks Assn—June, 1909. No. 5908 N.

Government Control.

Wisconsin Public Utility Law: Its Operation and Results. Charles B. Salmon. States the important provisions, discussing their value. 2500 w. Am W-Wks Assn—June, 1909. No. 5912 N.

Ground Waters.

Underground Water in Slate and Shale. Frederick G. Clapp. Gives information showing that successful wells are frequent in slate formations. Ills. 3500 w. Eng Rec—June 12, 1909. No. 5489.

Irrigation.

The American Desert and Its New Water Works. Arthur P. Davis. Brief illustrated account of the large irrigation projects in arid areas of the United States. 1200 w. Pro Am W-Wks Assn—1908. No. 5944 N.

Stray Notes on Engineering Matters in Egypt. J. C. Larminie. Illustrated review of works, including the Esna barrage and the Aswan reservoir and dam. 2000 w. Pub Works—Jan-March, 1909. No. 5646 D.

Long Island.

The Sources of and the Methods of Developing Long Island Water Supplies. Abstract of a paper by A. S. Farmer before the Municipal Engineers of the City of New York. Describes geologic conditions and development of wells. Ills. 7700 w. Engng-Contr—June 2, 1909. No. 5309.

Meters.

The Premier Meter. Arthur S. Tuttle. Illustrates and describes a precise apparatus for measuring the flow of water in large mains. 5000 w. Pro Am W-Wks Assn—1908. No. 5937 N.

Meters and Meter Rates. W. Volkhardt. Brief discussion of this subject. 1000 w. Am W-Wks Assn—June, 1909. No. 5913 N.

Practical Workings of Detector Meters. R. J. Thomas. Explains the advantages of such meters, especially where used on services intended for fire protection only. Discussion, with notes on Private Fire Protection by D. R. Gwinn. 7500 w. Pro Am W-Wks Assn—1908. No. 5930 N.

"Battery" Arrangement of Water Meters. George E. Booker. Illustrated description, with discussion. 1500 w. Pro Am W-Wks Assn—1908. No. 5983 N.

Meter Testing.

Discussion of the Probable Errors Due to the Apparatus and Gauges Used for the Commercial Test of Meters. Nicholas S. Hill, Jr. 14800 w. Pro Am W-Wks Assn—1908. No. 5932 N.

Municipal Ownership.

Municipal Ownership in Edmonton. A Maclean. A brief outline of successful municipal enterprises, including waterworks. 1700 w. Am W-Wks Assn—June, 1909. No. 5907 N.

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Newark, O.

History of the Water Works Question at Newark, Ohio. H. C. Hodgkins. A review, with general discussion. 3500 w. Pro Am W-Wks Assn—1908. No. 5981 N.

Nitrogen.

The Significance of Nitrogen in Its Various Forms in Water Supply. F. E. Hale. Aims to emphasize the lack of sanitary significance in the presence of high free ammonia, or nitrate in ground supplies. Discussion. 6000 w. Pro Am W-Wks Assn—1908. No. 5940 N.

Pipe Cleaning.

The Necessity of Laying Water Mains with the View of Future Cleaning. George F. Whitney. A short paper, introducing a general discussion. Ills. 2800 w. Pro Am W-Wks Assn—1908. No. 5933 N.

Pipe Corrosion.

The Comparative Values of Various Coatings and Coverings for the Prevention of Soil and Electrolytic Corrosion of Iron Pipe. Robert B. Harper. Extracts from a paper read before the Ill. Gas Assn. Shows the comparative value of various protective coverings, describing the tests made. Discussion. 10500 w. Pro Age—June 15, 1909. No. 5491.

Note on the Action of Water on Galvanized Iron. W. F. Monfort. Considers the action of a partially softened water upon the zinc coating of galvanized iron pipes as affecting their durability. Ills. 1500 w. Pro Am W-Wks Assn—1908. No. 5945 N.

Pipe Incrustation.

Character and Composition of the Incrustation from Discharge Pipe at Quincy, Illinois. Edward Bartow. Gives analysis of the incrustation, and also of the water. General discussion. 6000 w. Pro Am W-Wks Assn—1908. No. 5934N.

Pipe Specifications.

Standard Specifications for Cast Iron Pipe and Special Castings. Tables and illustrations. 7500 w. Pro Am W-Wks Assn—1908. No. 5989 N.

Pipe Trenches.

See Sewer Trenches, under MUNICIPAL.

Pollution.

The Sanitary Condition of the Southern End of Lake Michigan. J. Herbert Brewster. A study of the pollution of Lake Michigan and the condition of public water supplies, with recommendations for remedying the situation. 7000 w. Diagrams. Am W-Wks Assn—June, 1909. No. 5904 N.

Pumping.

See Pumping Engines, and Pumping Plants, under MECHANICAL ENGINEERING, HYDRAULIC MACHINERY.

Purification.

The Purification of Water Supplies. John J. Flather. Considers methods in use in various cities, their efficiency, cost, etc. 5500 w. Minn Engr—May, 1909. No. 5562 C.

Water Softening or Purification and Its Saving. M. Miller. Considers methods, results, costs, etc. Ills. 3500 w. Am W-Wks Assn—June, 1909. No. 5910 N.

The Sterilization Plant of the Jersey City Water Supply Company at Boonton, N. J. J. L. Leal. Describes the process of water purification. 3500 w. Am W-Wks Assn—June, 1909. No. 5918 N.

Description of Methods of Operation of the Sterilization Plant of the Jersey City Water Supply Company at Boonton, N. J., and Discussion of Results of Analysis of Raw and Treated Water, with notes on the Cost of the Treatment. George A. Johnson. 3000 w. Am W-Wks Assn—June, 1909. No. 5920 N.

The 40,000,000 Gal. Disinfecting Plant of the Jersey City Water Supply Company, at Boonton, N. J. Abstracts of three papers presented to the Am. W-Wks. Assn., at Milwaukee, June, 1909. J. L. Leal gives the history of the plant; George W. Fuller the nature of the process; George A. Johnson the operation of the plant. Ills. 6000 w. Eng News—June 24, 1909. No. 5868.

Description of the Process and Plant of the Jersey City Water Supply Company for the Sterilization of the Water of the Boonton Reservoir. George W. Fuller. Outlines the more important details. 4500 w. Am W-Wks Assn—June, 1909. No. 5919 N.

See also Concrete, under CIVIL ENGINEERING, CONSTRUCTION.

Rates.

Water Rates Charged in 375 Cities. D. R. Gwinn. Gives a statement of rates, with the object of showing that the average report gives no accurate information in regard to cost of water furnished. Discussion. 9000 w. Pro Am W-Wks Assn—1908. No. 5935 N.

Water Meter Rates. George B. Bassett. Explans method of adjusting rates. 2500 w. Pro Am W-Wks Assn—1908. No. 5985 N.

What Would Be a Proper Charge for a Service Under These Conditions. S. C. Robinson. A statement of the conditions, with discussion. 6500 w. Pro Am W-Wks Assn—1908. No. 5982 N.

Collection of Rates. Thomas Stone. Explains methods adopted at Greenville, Pa. 1200 w. Pro Am W-Wks Assn—1908. No. 5942 N.

See also Meters, under WATER SUPPLY.

Reservoirs.

The Principal Reservoirs and Dams of the World. Arthur Lakes. Discussion of various types of dams and not-

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able examples. Ills. 3000 w. Min Wld —June 5, 1909. No. 5376.

Methods Used in Preliminary Work on Catskill Reservoirs for a 500-Million Gallon Daily Supply for the City of New York. J. S. Langthorn. A full report of this work, with plans, maps, illustrations and short discussion. 75,000 w. Pro Brooklyn Engrs' Club, No 79—1908. No. 5870 F + F.

Run-Off of Some Representative Streams of the United States. M. T. Rogers and H. U. Ransom. Gives results of a study of stream-flow and run-off in different parts of the United States. Diagrams. 4000 w. Harvard Engng Jour—June, 1909. No. 5990 D.

Selection.

The Selection of a Water Supply. Henry N. Ogden. Suggestions of importance in determining the quantity, cost and quality. 3000 w. Pro Am W-Wks Assn—1908. No. 5986 N.

Softening.

Water Treatment by Electricity. Abstract of a paper by J. L. Campbell before Am. Ry. Engineering and Maintenance of Way Assn., describing experiments in reducing the hardness of water by electricity. 850 w. Elec Age—May. 1909. No. 5430.

Standpipes.

See Tanks, under WATER SUPPLY.

Staten Island.

Acquisition by New York City of the Larger of Two Water Systems of Staten Island. Louis L. Tribus. An account of water supply of the island and matters related, giving tables and illustrations. 3000 w. Am W-Wks Assn—June, 1909. No. 5926 N.

Tanks.

Water Storage in Elevated Tanks and Stand Pipes. H. E. Horton. Considers the use and advantage of elevated tanks and stand pipes. Discussion. Ills. 6500 w. Jour W Soc of Engrs—June, 1909. No. 5880 D.

Washington, D. C.

The Aqueduct System and Filtration Plant of Washington, D. C. Francis F. Longley. Gives the history and an illustrated description of the works, with costs. 5500 w. Pro Am W-Wks Assn —1908. No. 5984 N.

Water Works.

The American Water-Works Association. Abstracts of the papers read at the Milwaukee convention. 33800 w. Eng Rec—June 19, 1909. No. 5624.

Water Works of the United States. Information, tabulated data, and statistics from 350 plants. 9500 w. Munic Jour & Engr—June 2, 1909. No. 5205.

Competitive Water Works. Charles R. Henderson. Considers instances of competition in the business of supplying municipalities with water. Discussion. 3000 w. Pro Am W-Wks Assn—1908. No. 5980 N.

Ownership of Public Utilities. C. W. Wiles. Short paper, introducing general discussion. 2800 w. Pro Am W-Wks Assn—1908. No. 5947 N.

WATERWAYS AND HARBORS.

Canals.

The Canals of Canada. Gives statistics relating to cost of construction, some traffic comparisons, etc. 1000 w. Can Engr—June 18, 1909. No. 5611.

Coast Erosion.

Erosion of the Coast and Its Prevention. F. W. S. Stanton. An appendix to previous articles. Deals with the Thames estuary. Ills. 2500 w. Pub Works—Jan-March. 1909. No. 5644 D.

Diving.

See Wharves, under WATER SUPPLY.

Ferryhouses.

Superstructure of the Liberty Street Ferryhouse, New York. Plans and description of this passenger terminal of the C. R. R. of N. J. 1500 w. Eng Rec—May 29, 1909. No. 5147.

Harbor Pollution.

The Discharge of Sewage into Tidal Waters. George A. Soper. Discusses the sanitary protection of tidal harbors. 6000 w. Sch of Mines Qr—April, 1909. No. 5900 D.

Lighthouses.

The Substructure for the White Shoal Light, Lake Michigan. Explains conditions to be met in the construction of a lighthouse at the extreme northern end of Lake Michigan, and the methods adopted. Ills. 2200 w. Eng Rec—June 12, 1909. No. 5484.

Locks.

The Accident to the Lock Gates at the Canadian Canal, Sault Ste. Marie. Illustrated account of the wrecking of the lower gates of the lock of the Canadian Canal, on June 9, 1909. 1200 w. Eng News—June 17, 1909. No. 5581.

The Accident at the Canadian Lock at Sault Ste. Marie. Gives details of the accident and the methods of closing the canal, with illustrations. 2500 w. Eng Rec—June 19, 1909. No. 5625.

A Suggestion of a Type of Lock for the New Government Canal at Sault Ste. Marie—Including a Criticism of the Present Poe Lock. George A. Burley. Map and Ills. 5500 w. Eng News—June 24, 1909. No. 5865.

See also Dams, under WATER SUPPLY.

Piers.

The Construction and Consolidation of Piers at Port de la Pointe des Galets (Etude sur la Construction et la Con-

solidation des Jetées du Port de la Pointe des Galets). Gaston Bidel. Illustrated description of important work in the harbor of Reunion Island. 14000 w. Ann d Ponts et Chaussées—1909-II. No. 5715 E + F.

River Regulation.

The Regulation of the Lech in Austrian Territory (Die Lechregulierung auf österreichischem Gebiete). Herr Krapf. A brief description of the works projected. Plate 2500 w. Oest Wochenschr f d Oeffent Baudienst—May 22, 1909. No. 5793 D.

San Francisco.

A Great Pacific Harbor. History of the harbor of San Francisco, with notes on the new works. 1700 w. Pub Works—Jan-March, 1909. No. 5647 D.

Sydney, Australia.

Sydney Harbor, New South Wales. Information from the report of the Sydney Harbor Trust commission, with description of the general characteristics of the port. 2000 w. Engr, Lond—June 11, 1909. No. 5635 A.

U. S. Waterways.

The Report Upon the Proposed 14-ft. Deep Waterway from Chicago to New Orleans. Reports of the Board appointed by the U. S. Congress, and the General Board of Engineers on Rivers and Harbors, and comment by General Marshall. Also editorial. 15000 w. Eng News—June 24, 1909. No. 5866.

Water Powers.

The Valuation of Water Power and the Estimation of Stream Diversion Damages. Robert E. Horton. Discusses various phases of this subject, giving opinions based on water power litigations. 9500 w. Am W-Wks Assn—June, 1909. No. 5903 N.

The Susquehanna River as a Source of Power. Mason D. Pratt. Read before the Engrs' Club of Central Penn. A study of data and hydrographs with the view of showing some of the limitations of this river. 4500 w. Eng News—June 10, 1909. No. 5461.

Wisconsin's Water Power Resources. L. S. Smith. An illustrated article, giving an outline of the undeveloped water powers. 1600 w. Wis Engr—June, 1909. No. 5694 D.

Westland's Water Power Resources. Percy Gates Morgan. Illustrated account of the important sources of water power in this part of New Zealand, with an account of the h. p. available. 2500 w. N Z Mines Rec—April 16, 1909. No. 5821 B.

Wharves.

The Construction of a Quay Wall in Open Water by Divers. Notes from a paper by John Taylor, before the Can. Soc. of Civil Engrs., describing his work at Portland Harbor. 2500 w. Eng Rec—May 28, 1909. No. 5150.

MISCELLANY.

Army Engineers.

Engineers and the Territorials. Discusses the engineer services of the British Territorial Army. 3000 w. Engr, Lond—May 21, 1909. No. 5197 A.

Earthquakes.

Earthquakes in the Light of the New Seismology. Oscar C. S. Carter. Outlines the theories advanced concerning the conditions of the earth below the surface, studies the causes of earthquakes, illustrating and describing seismographs and their use. 11500 w. Jour Fr Inst—June, 1909. No. 5806 D.

Nicaragua.

Labor Conditions on the Atlantic Coast of Nicaragua. H. D. Mendenhall. Discusses the difficulties involved with labor in engineering work in Central America and methods of dealing with laborers. 3500 w. Eng Rec—June 5, 1908. No. 5278.

Soil Erosion.

Opinions of Foreign Engineers on the Value of Forests for Preventing Erosion. Extract from a paper on "Conservation," by George F. Swain, before the Nat. Assn. of Cotton Mfrs. Gives extracts from reports from different countries. 1800 w. Eng News—May 6, 1909. No. 4524.

ELECTRICAL ENGINEERING.

COMMUNICATION.

Radiotelegraphy.

The Wireless Telegraph. W. B. Kouwenhoven. A brief explanation of electric waves and a description of the apparatus for their propagation. 3000 w. Ry & Loc Engng—June, 1909. No. 5236 C.

Researches in Radiotelegraphy. Prof. J. A. Fleming. Lecture before the Roy Inst. Gives a summary of results of recent research work. 2000 w. Elect'n, Lond—June 11, 1909. Serial. 1st part. No. 5653 A.

The Function of the Earth in Radiotelegraphy. J. A. Fleming. Refers freely to the paper by Dr. J. Zenneck, on "The Propagation of Plane Electromagnetic Waves Over a Plane Conducting Surface with Reference to Wireless Telegraphy," with added explanations. 1500

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w. Engng—June 4, 1909. Serial. 1st part. No. 5531 A.

Selective Wireless Telegraphy. Oliver Lodge. Description of experiments to test the facility and perfection of tuning in the Lodge-Muirhead system. 1800 w. Nature—May 27, 1909. No. 5268 A.

Bellini-Tosi System. Illustrates and describes a method of directing Hertzian waves. 1200 w. Sci Am Sup—June 12, 1909. No. 5405.

A New System of Wireless Telegraphy Used by the Telefunken Company. Count Arco. Explains the practical and technical advantages of this new system. 2500 w. Elec Rev, N Y— May 29, 1909. No. 5166.

The New Telefunken Telegraph. Count Arco. Describes a combination of the arc and spark systems. 3000 w. Sci Am Sup—June 19, 1909. No. 5585.

The Telefunken or Quenched Spark Discharger. J. A. Fleming. Describes experiments seeming to prove that the operative principles of the Telefunken and von Lepel dischargers are different. 900 w. Elect'n, Lond—June 11, 1909. No. 5650 A.

Note on Horizontal Receivers and Transmitters in Wireless Telegraphy. H. M. Macdonald. Read before the Roy. Soc. Considers the theory of such an arrangement. 1200 w. Elect'n, Lond—June 4, 1909. No. 5519 A.

A Note on the Production of Steady Electric Oscillations in Closed Circuits and a Method of Testing Radio-Telegraphic Receivers. J. A. Fleming and G. B. Dyke. Abstract of paper before the Phys. Soc. Describes apparatus at University College, London, and tests on various detectors. 1500 w. Elect'n, Lond—May 21, 1909. No. 5187 A.

The Utilization of the Total Radiation from an Inductively Coupled Antenna in Radiotelegraphy. J. A. Fleming. Briefly considers methods of avoiding energy loss. 700 w. Elect'n, Lond—June 11, 1909. No. 5651 A.

The Radio-Telegraphic Station at Cullercoats. S. M. Sörensen. Abstract of paper before the Newcastle Sec. of Inst. of Elec. Engrs. Describes the construction and working of a spark system. 2400 w. Elect'n, Lond—June 4, 1909. No. 5516 A.

Radiotelephony.

Improvements in the De Forest System of Wireless Telephony. Walter Kendall. Illustrates and describes recent developments, especially the installations of the Great Lakes Radio-Telephone Co. 1500 w. Sci Am—June 19, 1909. No. 5582.

Submarine Cables.

The New Victoria and Tasmania Telegraph Cables. Description of the first cables laid for the Commonwealth government connecting Flinders Bay, Victoria, and East Bay, Low Head, Tasmania. Ills. 800 w. Elec Engng—May 27, 1908. No. 5415 A.

Telautograph.

The Telautograph in Steel Mills. Illustrates and describes applications. 2000 w. Ir Trd Rev—June 17, 1909. No. 5586.

Telephony.

Neutralizing Transformers for Telephone Lines Paralleling Single-Phase Electric Railways. Abstract of article by J. H. Cannon, in Purdue Eng. Rev., describing the methods of eliminating disturbances in the telephone lines paralelling N. Y., N. H. & H. single phase system. Ills. 850 w. Ry & Engng Rev —June 5, 1909. No. 5371.

Telephotography.

Belin's Improved Apparatus for the Electrical Transmission of Pictures. Jacques Boyer. Illustrated description of this improved apparatus for the transmission of drawings and pictures. 1700 w. Sci Am—June 12, 1909. No. 5382.

DISTRIBUTION.

Condensers.

Some Tests and Uses of Condensers. W. M. Mordey. Discusses whether condensers can be used commercially in competition with over excited synchronous motors for the improvement of power factor in distribution. Also discusses use of condensers to extinguish arcs. Read before Institution of Elec. Engrs. Discussion. 6300 w. Elect'n, Lond—May 28, 1909. No. 5269 A.

Current Rectifiers.

The Constant Current Mercury Arc Rectifier. Charles J. Mundo. Description of such a set, explaining its operation. Diagrams. 2200 w. Harvard Engng Jour—June, 1909. No. 5993 D.

Wiring.

See Signalling, under RAILWAY ENGINEERING, CONDUCTING TRANSPORTATION.

DYNAMOS AND MOTORS.

A. C. Dynamos.

Calculation of Iron Losses in Dynamo Electric Machinery. G. E. Hanssen. Explains a method of predetermining the total iron loss. Ills. 1500 w. Pro Am Inst of Elec Engrs—June, 1909. No. 5832 F.

Comparative Costs of 25-Cycle and 60-Cycle Alternators. Carl J. Fechheimer. Aims to eliminate as far as possible the variables encountered in analyzing conditions affecting cost. 2000 w. Pro Am Inst of Elec Engrs—June, 1909. No. 5833 F.

"Phasing" Alternating Current Generators, F. J. Foote. Gives curves explaining principles involved. 1500 w. Power—June 15, 1909. No. 5494.

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Alternator for One Hundred Thousand Cycles. E. F. W. Alexanderson. Briefly reviews the history of the high-frequency alternator; and describes features of a recent machine. Ills. 2500 w. Pro Am Inst of Elec Engrs—June, 1909. No. 5837 F.

A. C. Motors.

Reduction in Capacity of Polyphase Motors Due to Unbalancing in Voltage. S. B. Charters, Jr., and W. A. Hillebrand. Reports a series of tests to determine their performance under other than ideal conditions. 2500 w. Pro Am Inst of Elec Engrs—June, 1909. No. 5831 F.

A Simple Method of Deriving the Heyland and Ossanas Circle Diagram (Ueber eine einfache Ableitung des Heylandschen und Ossanaschen Kreises). W. Rogowski. Mathematical. Ills. 2100 w. Elektrotech u Maschinenbau—May 30, 1909. No. 5960 D.

Armature Cooling.

Radial Cooling of Dynamo Armatures (Ueber die radiale Kühlung von Dynamoankern). G. Ossanna. A mathematical discussion of its possibilities. Ills. 2100 w. Elektrotech u Maschinenbau—May 23, 1909. No. 5956 D.

Armature Reactions.

Experimental Analysis of Armature Reaction. Dr. Gisbert Kapp. Abstract of a communication to the Inst. of Elec. Engrs. Describes two tests for separating the reactance voltage and the drop produced by armature back excitation in a polyphase armature. 2500 w. Elect'n, Lond—June 4, 1909. No. 5517 A.

Automobile Motors.

See Electric, under MECHANICAL ENGINEERING, AUTOMOBILES.

Induction Motors.

The Heating of Induction Motors. A. Miller Gray. Shows the limitations imposed on the designer of induction motors by the heating of the machine, and how this heating may be predetermined. 3000 w. Pro Am Inst of Elec Engrs—June, 1909. No. 5834 F.

Interpoles.

Interpole Designs. W. B. Hird. Read before the Glasgow Sec. of the Inst. of Elec. Engrs. Explains the principle of all interpole designs, discussing their use. General discussion. 6000 w. Elec Engr, Lond—May 21, 1909. No. 5184 A.

Railway Motors.

Oerlikon Alternating-Current Railway Motors and Their Effects on Telephone Systems. Dr. Behn-Eschenburg. Gives results of general interest in single-phase traction, showing how difficulties have been overcome. 2500 w. Elect'n, Lond—May 21, 1909. No. 5186 A.

Repulsion Motors.

Repulsion Motor With Variable Speed Shunt Characteristics. E. F. W. Alexanderson. Presents the general principles of a theory for the a. c. shunt motors. Diagrams. 2000 w. Pro Am Inst of Elec Engrs—June, 1909. No. 5836 F.

Synchronous Motors.

Self-Starting Synchronous Motors. Jens Bache-Wüg. An illustrated explanation of the starting performance of such motors. 2000 w. Elec Jour—June, 1909. No. 5548.

ELECTRO-CHEMISTRY.

Corrosion.

The Electrolytic Theory of the Corrosion of Iron and Its Applications. William H. Walker. Read before the I. and S. Inst. Explains this theory, showing that it includes the carbonic acid theory, and points out practical applications. Ills. 4500 w. Ir & Coal Trds Rev—May 14, 1909. No. 5135 A.

Nitrogen.

The Fixation of Atmospheric Nitrogen (Der gegenwärtige Stand der Stickstoffrage). L. Max Wohlgemuth. A brief review of the present state of the industry, the products, etc. 2700 w. Stahl u Eisen—May 19, 1909. No. 5749 D.

Utilization of Atmospheric Nitrogen Particularly for the Manufacture of Air-Saltpetre. Dr. A. Beruthsen. Abstract of a paper read at the Int. Cong. of Am. Chem. Deals especially with the application and methods. 3000 w. Elect'n, Lond—June 11, 1909. No. 5652 A.

The Manufacture of Nitrates from the Atmosphere by the Electric Arc—Birkeland-Eyde Process. Sam Eyde. Describes power station and plant for working this process at Notodden. Ills. 5200 w. Jour Soc Arts—May 28, 1909. No. 5406 A.

The Process of the Badische Company for the Fixation of Atmospheric Nitrogen. Abstract of a paper before the Berlin Electrical Society by Dr. Schoenherr, describing the special type of electrical furnace and methods now employed. Ills. 2700 w. Elec-Chem & Met Ind—June, 1909. No. 5344 C.

Water Electrolysis.

A New Electrolyzer. Describes a new type of Electrolyzer designed to furnish oxygen and hydrogen at high pressure for industrial work and capable of being used with either high or low current. Ills. 3000 w. Sci Am Sup—June 5, 1909. No. 5314.

ELECTRO-PHYSICS.

Electrons.

The Electron Theory of Currents and their Properties (Théorie électronique des Courants et de leurs Propriétés). H. Pellat. A general explanation of the electron theory. 5000 w. Bul Soc Int des Elecns—May, 1909. No. 5718 F.

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Hysteresis.

Differential Ballistic Methods of Measuring Hysteresis Losses. R. Beattie and P. M. Elton. Describes a method that is quick in operation and has the advantage that it refers to short test pieces. 3000 w. Elect'n, Lond—June 4, 1909. Serial. 1st part. No. 5518 A.

Magnetic Properties.

Silicon and its Influence on the Electric and Magnetic Properties of Iron. Discussion of various researches made with silicon and silicon alloys. 2600 w. Engng—May 28, 1909. No. 5262 A.

Radioactivity.

Radioactivity in Geology and in the Atmosphere (La Radioactivité en Géologie et dans l'Atmosphère). M. P. Besson. Discusses the recent progress of knowledge as the significance of radioactivity in geology and meteorology. Ills. 6800 w. Mem Soc Ing Civils de France—March, 1909. No. 5702 G.

GENERATING STATIONS.

Accumulators.

Automatic Load Regulation on Traction Systems—An Example of Successful Storage-Battery Engineering. F. W. Laas. Paper read before Iowa Electrical and Railway Association in which economy of the storage battery is shown. Ills. 2700 w. Elec Rev, N Y—June 5, 1909. No. 5422.

See also Electric Power, under MARINE AND NAVAL ENGINEERING.

Central Stations.

The Design and Requirements of Electric Power Works. Horace Boot. Paper read before (British) Institution of Mechanical Engineers. Discusses site, requirements, destructors, engines, etc. Ills. 3200 w. Surveyor—May 28, 1909. No. 5450 A.

Central Station Design and Distribution. E. P. Hollingdale. Read before the Elec. Assn. of N. S. W. Discusses details of importance in this connection. 2500 w. Aust Min Stand—May 12, 1909. Serial. 1st part. No. 5824 B.

The Distribution Department. H. F. J. Thompson. Considers the staff needed to secure efficient and economical working, the duties, etc. 2500 w. Elec Rev, Lond—June 11, 1909. No. 5648 A.

The Relative Advantages of Reciprocating Engines and Turbines for Traction Generating Stations. G. Rizzo. Abstract of a report on replies to questions sent out, discussing the boiler-house problem, and considering the heat cycles produced by both reciprocating engines and turbines. 3000 w. Elect'n, Lond—June 11, 1909. No. 5649 A.

Large Central Stations in Light-Railway Development (Wirtschaftliche Bedeutung grosser Ueberlandzentralen für die Entwicklung des Kleinbahnwesens). O. Petri. An economic discussion. Ills. Serial. 1st part. 1800 w. Elek Kraft u Bahnen—May 24, 1909. No. 5954 D.

The Easton Gas and Electric Company's plant. Edward T. Binns. Description of a large steam and water power electric plant. Ills. 1650 w. Power—June 8, 1909. No. 5320.

System of the Philadelphia Electric Company. Illustrated account of the methods of generation, distribution and sale of electrical energy. 5500 w. Elec Wld—May 27, 1909. No. 5224.

New Features of Central Station Service in Chicago. F. H. Bernhard. Illustrated detailed description of the three generating plants, the transmission system and substations. 5000 w. Elec Rev, N Y—May 29, 1909. No. 5164.

Power Generating System and Records of the Twin City Rapid Transit Co. Description of the new Hennepin Island Power Station, Minneapolis, and recent additions to the steam power station. Ills. 4500 w. Elec Ry Jour—June 5, 1909. No. 5250.

Central Power Plant at the U. S. Navy Yard, Charleston, S. C. A. P. Ball. Describes a new plant replacing several small stations and supplied with two 500-k. w. turbo-generators. Ills. 2000 w. Elec Wld—June 3, 1909. No. 5271.

Producer Gas-Engine Station at Hoopeston. Ill. Describes a 280-hp gas engine supplied by two producers of the Munzel type driving a 200 k. w. 60 cycle, 2300 volt alternator. Ills. 4000 w. Elec Wld—June 3, 1909. No. 5270.

Operating Features of the Spy Run Power House. M. J. Kehoe. Abstract of a paper before the Cent. Elec. Ry. Assn. Gives the principal features of the station and the operation. 2000 w. Elec Ry Jour—June 12, 1909. No. 5358.

Central-Station Practice and Results from Waterloo, Ia. Illustrated description of a progressive management. 2500 w. Elec Wld—June 10, 1909. No. 5400.

Sydney Municipality Electrical Undertaking. Abstract of report by Major Cardew on the condition and extension of this large plant. Ills. 1500 w. Aust Min Stand—April 28, 1909. No. 5396 B.

Auxiliary Steam-Driven Electric Station at Rome, Italy. S. B. Jones. Illustrated detailed description. 2000 w. Elec Wld—June 24, 1909. No. 5891.

A Twenty Thousand Horse-Power German Municipal Steam Turbine Plant. Frank C. Perkins. Describes the Frankfort-on-the-Main plant. Ills. 1350 w. Can Engr—June 4, 1909. No. 5389.

See also Turbines, under MECHANICAL ENGINEERING, STEAM ENGINEERING.

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Economics.

Profitable Day Loads for the Central Station. S. A. Fletcher. Suggests domestic and commercial applications of electric current. 2200 w. Elec Jour—June, 1909. No. 5551.

The Extension of Electric Service to Outlying Communities. Abstract of paper by J. S. Knowlson, before Northwestern Electrical Assn, in which the opportunities for small as well as large generating stations to extend their service are indicated. 2400 w. Elec Rev, N Y—June 5, 1909. No. 5426.

Hydro-Electric.

The Architecture of Hydro-Electric Stations. Frank Koester. Illustrated discussion of building designs. 2000 w. Cassier's Magazine—June, 1909. No. 5541 B.

A Farm Hydro-Electric Plant Without Operating Attendant. P. J. O'Gara. Description of a domestic plant automatically controlled from a residence a quarter of a mile from the waterfall. Supplies power to a house and farm at an initial cost of less than $1,500. Ills. 3000 w. Elec Wld—June 3, 1909. No. 5272.

Harnessing the Torrents. Describes the work of conserving and utilizing the water power of the Susquehanna and the Connecticut rivers. Ills. 2200 w. Pub Works—Jan-March, 1909. No. 5645 D.

Sioux Falls Hydro-Electric Development. Simpson Rice. Illustrated description of a plant of interest on account of the provisions made to take care of flood water, and unusual arrangements and construction. 3000 w. Power—June 22, 1909. No. 5811.

The Cedar River Power Development of the City of Seattle, Washington. Louis P. Zimmerman. Illustrated detailed description of the largest municipal hydro-electric plant in the United States. 3000 w. Eng News—June 17, 1909. No. 5574.

The Hennepin Power House of the St. Anthony Falls Water Power Company. R. D. Thomas. Illustrated description of a plant at Minneapolis, which utilizes the flood waters of the Mississippi River. 2000 w. Eng Rec—May 29, 1909. No. 5142.

The New Power Station of the McCall Ferry Power Company. Newton Harrison. Illustrated description of this station on the Susquehanna River. 2000 w. Cent Sta—June, 1909. No. 5152.

Water Power Development in and About Quebec. Illustrated descriptions of the three large power concerns furnishing light and power to the city. 4500 w. Can Elec News—June, 1909. No. 5465 C.

Municipal Electric Plant in Karlstadt, Croatia (Das städtische Elektrizitätswerk in Karlstadt, Kroatien). Karl Thien. Illustrated description. 3000 w. Elektrotech u Maschinenbau—May 16, 1909. No. 5955 D.

The Burglauenen Electric Plant (Das Elektrizitätswerk Burglauenen). E. Froté. Illustrated description of an interesting Swiss hydro-electric plant and pipe line. Serial. 1st part. 2000 w. Schweiz Bau—May 15, 1909. No. 5768 B.

Regulation and Hydro-Electric Works of the Skien River, Norway. (Seeregulierungen und Wasserkraftanlagen im Gebiet des Skienflusses in Norwegen). Herr Dubislav. Describes several interesting works. Ills. Serial. 1st part. 2800 w. Zeitschr f d Gesamte Turbinenwesen—May 29, 1909. No. 5781 D.

Hydro-Electric Plant of the Norwegian Nitrogen Products Company at Svælgfos, near Notodden (Usine hydro-électrique de la Société Norvégienne de l'Azote, à Svælgfos, près Notodden, Norvège). Sam Eyde and S. Kloumann. Illustrated description of a plant generating energy for the nitrate works. Serial. 1st part. 5000 w. Génie Civil—May 15, 1909. No. 5739 D.

The Svälgfos Electric Plant of the Norwegian Nitrogen Products Company at Notodden, Norway (Das Kraftwerk Svälgfos der Norsk hydro-elektrisk Kvälstofaktieselskab bei Notodden in Norwegen). Sam Eyde and S. Kloumann. Illustrated description. Serial. 1st part. 5000 w. Zeitschr d Ver Deutscher Ing—May 1, 1909. No. 5957 D.

See also Central Stations, under GENERATING STATIONS.

Isolated Plants.

The Relation Between Engine-Room and School-Room, and How to Attain It. Discussion of the operation of the isolated plant and the proposed plan to require two years' actual service before admitting a young man to apprenticeship. 1300 w. Elec Age—May, 1909. No. 5428.

Alternating-Current Industrial Power Plants. Warren H. Miller. Discusses the application of alternating current to a manufacturing plant, showing what can be done in even a small installation. Ills. 3500 w. Elec Wld—June 3, 1909. No. 5273.

Operation

Operating Features of Various Generating Systems. Illustrated detailed description of the efficient organization of operating forces and control of apparatus in emergencies. 17000 w. Elec Wld—May 27, 1909. No. 5225.

LIGHTING

Illumination.

Why Laboratory Efficiency of a Light Source Differs From Efficiency of Illumination. A. L. Eustice. Shows that illumination efficiency depends on con-

ditions as well as on the individual source of light. 1500 w. Elec Rev, N Y —May 29, 1909. No. 5167.

Illumination Cost Factors. Max Harris. Explains methods used in figuring cost of illumination, discussing the factors to be considered. 3000 w. Elec Jour—June, 1909. No. 5547.

See also Shop Lighting, under MECHANICAL ENGINEERING, MACHINE WORKS AND FOUNDRIES.

Incandescent Lamps.

The Progress of the Metallic Filament Lamp. Herbert T. Wade. A review of recent developments. 1500 w. Sci Am—June 5, 1909. No. 5355.

Practical Treatise on Tungsten and Carbon Lamps. H. D. Burnett. Showing by charts the results of a series of life tests. 4500 w. Can Elec News—June, 1909. No. 5466 C.

The Tungsten Lamp and Its Behavior on Life Tests as Compared With Carbon Lamps. H. D. Burnett. Discusses the objections to these lamps, their efficiency, and results of life tests, with matters related. General discussion. 14500 w. Can Soc of Civ Engrs, Bul 5—May, 1909. No. 5854 N.

Photometry.

Important International Agreement on Photometric Units. Reports an agreement between England, France and the United States upon a unit of candle-power of luminous intensity to be known as the international candle. 2000 w. Elec Wld—May 27, 1909. No. 5223.

Street.

The Illumination of Streets. C. E Stephens. Discusses the problem and the advantages of the incandescent lamp for outlying districts. 3000 w. Elec Jour—June, 1909. No. 5549.

Ornamental Curb Line Illumination. D. F. Fradette. Describes decorative street lighting in the United States. Ills. 1500 w. Elec Rev, N Y—June 5, 1909. No. 5424.

MEASUREMENT.

Alternating Current.

Measurement of Alternating Current Energy. M. A. Sammett. Considers briefly the necessity for selection of proper current and potential transformers, effects of phase displacements and power factor. 1200 w. Can Elec News—June, 1909. No. 5467 C.

Dynamo Testing.

Efficient Test of Three-Wire Balancing Dynamos. J. W. Hemmelsbach. Describes test of two a. c. generators forming a balancing set on a three-wire 250 volt system. Ills. 1100 w. Power—June 8, 1909. No. 5319.

Meter Testing.

Some Notes on Meter-Room Practice. Discusses the organization, work, and testing of the meter department of a central station. 1300 w. Elec Engr, Lond —May 28, 1909. No. 5413 A.

Motor Testing.

The Efficiency of Asynchronous Machines Tested by the Loading-Back Method. Stanley P. Smith. Describes a new application of the no-load and zero-speed circle diagram. Also editorial. 3500 w. Elec Wld—June 17, 1909. No. 5572.

Transformer Testing.

Testing of Transformers in Central Stations. Omer F. Dubruiel. Presents methods of testing which will assist operators in testing transformers of any make. 3500 w. Elec Rev, N Y—May 29, 1909. No. 5165.

POWER APPLICATIONS.

Marine Propulsion.

See Electric Power, under MARINE AND NAVAL ENGINEERING.

Observatory.

Electricity at Harvard College Observatory. Howard S. Knowlton. Illustrates and describes the many applications at the observatory. 2500 w. Elec Wld—June 24, 1909. No. 5890.

Shipboard.

See Electric Power, under MARINE AND NAVAL ENGINEERING.

Theatres.

Electricity in the Production of "Joan of Arc." Brief account of the many uses made of electricity in the recent presentation at the Harvard Stadium. 1000 w. Elec Wld—June 24, 1909. No. 5889.

Water Softening.

See Softening, under CIVIL ENGINEERING, WATER SUPPLY.

TRANSMISSION.

Cable Drawing.

The Use of Fish Wire in Conduit Work. Arthur Gillman. Discusses "fishing" the conduit, and the fastening of the fishing wire to the electrical conductors, or to a pulling-line. 1500 w. Elec Wld—June 24, 1909. No. 5893.

Cables.

The Resistance and Reactance of Armored Cables. J. B. Whitehead. Gives calculations showing that even at 60 cycles, and with outgoing and return cables placed close together, the reactance would not be serious. 2500 w. Pro Am Inst of Elec Engrs—June, 1909. No. 5830 F.

Conduits.

Recent Improvements in Underground Conduit Construction. S. B. Way. Illustrated description of the monolithic, all-concrete conduits. 2000 w. Elec Wld—June 17, 1909. No. 5573.

We supply copies of these articles. See page 887.

The Arrangement of Underground Conduit for Electrical Distribution. Sydney W. Ashe. Describes conduits and distribution system employed in New York City. Ills. Serial. 1st part. 4500 w. Elec Wld—June 3, 1909. No. 5274.

Grounding.

Grounding the Secondary. Opinions of central stations on this subject, received by W. J. Canada. Also editorial note. 3000 w. Elec Wld—May 27, 1909. No. 5226.

Lightning Arresters.

An Aluminum Lightning Arrester Installation. Illustrated description of the installation to protect the transmission system of the Schenectady Power Co.'s 40-cycle, three-phase generating station. 1800 w. Eng News—June 10, 1909. No. 5462.

Line Construction.

Heavy Wire Terminations. Anthony Gorham. Illustrated discussion of methods of construction, especially the use of a cable clamp and strain insulator. 2000 w. Elec Wld—May 27, 1909. No. 5227.

Line Design.

Calculation of the High-Tension Line. Percy H. Thomas. Discusses the calculation as relating to regulation and energy line loss, and with especial reference to the unusually long and high power lines, deriving formulae. 6500 w. Pro Am Inst of Elec Engrs—June, 1909. No. 5829 F.

An Exact Method for the Determination of the Efficiency, Regulation or Size of Transmission Conductors. Harold Pender. Gives exact formulae for the calculation of the various quantities. 3000 w. Elec Wld—June 10, 1909. No. 5401.

Lines.

110,000-Volt Transmission Line at Grand Rapids. Illustrated description of this successful high-tension transmission system. 1800 w. Can Elec News—June, 1909. No. 5468 C.

Transmission System of Boston & Northern and Old Colony Street Railway Companies. J. W. Palmer, Jr. Paper read before New England Street Railway Club describing a system having 380 miles of track. Ills. 2000 w. Elec Ry Jour—June 5, 1909. No. 5251.

See also Central Stations, under GENERATING STATIONS.

Losses.

Output and Regulation in Long-Distance Lines. Percy H. Thomas. Discusses more especially the line-output, regulation or voltage-variation, and the line energy-loss. 9800 w. Pro Am Inst of Elec Engrs—June, 1909. No. 5828 F.

Motor Converters.

The Theory and Application of Motor Converters. H. S. Hallo. Read before the Inst. of Elec. Engrs. An explanation of the principle, operation, design, and characteristics. Ills. 3000 w. Elec Engr, Lond—May 21, 1909. Serial. 1st part. No. 5185 A.

Permutators.

The Permutator. F. J. Wellhouse. An explanation of this machine, a form of electric current converter, and its possibilities, illustrating types. 1500 w. Sib Jour of Engng—June, 1909. No. 5807 C.

Transformers.

The Limitations of Party Transformer Distribution. J. Frank Martin. Considers the minor engineering principles and details essential to the highest efficiency of apparatus. Ills. 1700 w. Elec Age—May, 1909. No. 5429.

Large Transformers for Electrochemical Applications (Transformateurs de grande Puissance pour Applications electrochimiques). Gives data of performance of apparatus built by the Oerlikon Company. Ills. 4500 w. L'Elecn—May 29, 1909. No. 5730 D.

Voltage Regulation.

See Losses, under TRANSMISSION.

MISCELLANY.

Agriculture.

The Influence of Electricity on Vegetation (Die Beeinflussung des Planzenwachstums durch Elektrizität). Max Breslauer. A review of researches and recent results. Serial. 1st part. 2200 w. Elektrochem Zeitschr—April, 1909. No. 4853 D.

Electromagnets.

The Weiss Laboratory Electromagnet and the Cotton Absolute Electromagnetic Balance (Elektromagnete für Laboratoriums zwecke von Prof. Dr. P. Weiss und die absolute elektromagnetische Wage von Cotton). Georges Zindel. Illustrated description of these instruments. 2200 w. Schweiz Bau—May 8, 1909. No. 5767 B.

High-Frequency Apparatus.

The Construction of High-Frequency Apparatus. George T. Hanchett. Describes features to be recommended by reason of their convenience and low cost. Ills. 2200 w. Elec Wld—July 1, 1909. No. 6108.

Resistances.

Self-Regulating Resistances (Neuerungen an selbstregelnden Belastungswiderständen). Martin Kallman. Illustrated description of types and discussion of their principles. 1800 w. Elek Kraft u Bahnen—April 24, 1909. No. 5065 D.

Spark Coils.

The Design and Operation of Jump-Spark Coils. F. W. Springer. An investigation of the varieties of spark obtainable, as generated by jump-spark coils of the vibrating and non-vibrating types. Also editorial. 4500 w. Elec Wld—June 24, 1909. No. 5892.

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INDUSTRIAL ECONOMY.

Accidents.

Industrial Accidents and Employer's Liability. Information from a pamphlet giving results of an investigation at Pittsburg, made by Miss Crystal Eastman. 6000 w. Eng News—June 17, 1909. No. 5575.

Apprenticeship.

See same title, under RAILWAY ENGINEERING, MISCELLANY.

Cost Systems.

A Cost System that Controls Costs. Herbert M. Rich. Explains the system of the Cleveland Automatic Machine Co. Ills. 3500 w. Am Mach—Vol. 32. No. 23. No. 5387.

A Factory Stock and Cost-Keeping System. Walter J. Spiro. Describes the plan adopted successfully by a manufacturing concern. 3500 w. Sch of Mines—April, 1909. No. 5901 D.

Foundry Costs. B. A. Franklin. Presents a system in operation that not only gives the cost of a casting, but shows the variation of the elements of manufacture. 2500 w. Am Found Assn—June, 1909. No. 5605 N.

See also Management, under INDUSTRIAL ECONOMY.

Depreciation.

Depreciation of Power Plant Equipment. F. H. Neely. Discussion of the subject which calls attention to the lack of uniformity of prevailing practice. 1150 w. Power—June 8, 1909. No. 5326.

Education.

Industrial Education. H. F. Baillet. Paper read before the Association of Master Plumbers of N. J. Discusses the development and need of industrial education in the U. S. and the attitude of the master plumber. 1700 w. Met Work—June 5, 1909. No. 5361.

Education for Utility and Culture. Dr. Calvin M. Woodward. Address at Missouri Sch. of Mines. Reviews the history of university development, and the field of human activities and culture. 4500 w. Eng News—June 24, 1909. No. 5864.

Some Comments on Our Engineering Education and the Men It Produces. Abstract of a lecture by W. D. Taylor before the Engng. Club of the Univ of Illinois, and repeated at the Univ. of Wisconsin. 9000 w. Wis Engr—April, 1909. No. 5687 D.

Two Sides of University Life. Arthur Twining Hadley. Speech to the students of Johns Hopkins University, Feb. 22, 1909. 3500 w. Yale Sci M—June, 1909. No. 5686 C.

The University of Sheffield: Department of Applied Science. Illustrated description of the buildings, and the work done. 2400 w. Col Guard—June 11, 1901. Serial. 1st part. No. 5654 A.

The College of Engineering of the Tokyo Imperial University. B. Arakawa. An account of this college and its work. 1800 w. Sib Jour of Engng—June, 1909. No. 5808 C.

Mining Education and the New Essen School (Das Bergschulwesen und das neue Bergschulgebäude in Essen). Herr Cabolet. Describes the new building and its equipment. Ills. 4000 w. Glückauf—May 15, 1909. No. 5758 D.

Labor.

See Nicaragua, under CIVIL ENGINEERING, MISCELLANY.

Management.

A Comprehensive Foundry Production Tally. C. E. Knoeppel. Outlines a method for collecting the principal production and cost figures. 5000 w. Am Found Assn—June, 1909. No. 5606 N.

Systematized Foundry Management and Foundry Costs (Systematisierte Giessereibetriebe und die hierbei in Ansatz zu bringenden Betriebskosten). W. Heym. A discussion of the fundamental principles of foundry management. Serial. 1st part. 1800 w. Giesserei-Zeit—May 1, 1909. No. 5764 D.

Natural Resources.

Chemistry and the Conservation of Our Forests and Minerals. Marston Taylor Bogert. Part of the author's presidential address on "The Function of Chemistry in the Conservation of Our Natural Resources." 10000 w. Sch of Mines Qr—April, 1909. No. 5899 D.

Profit Sharing.

Co-Partnership in Coal Mining. Describes the extension by Sir Christopher Furness of his co-partnership proposals from the ship-yards to the coal mining industry. 2700 w. Ir & Coal Trds Rev—May 28, 1909. No. 5410.

Stores Keeping

Stores Keeping in Industrial Plants (Behandlung von Bestellungen im Fabrikbetriebe). C. M. Lewin. Outlines the principles and a system. Ills. 4000 w. Zeitschr f Werkzeug—May 25, 1909. No. 5787 D.

Unemployment.

The Role of State and Municipality in Unemployment Insurance (Du Rôle de l'Etat et des Communes en Matière d'Assurances contre le Chômage). Paul

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Vergasi. A general discussion of the problem, with description of a number of schemes being tried in France. 3500 w. Rev d'Econ Indus—May 16, 1909. No. 5701 D.

Unemployment and Its Insurance (Arbeitslosigkeit und Arbeitlosen-Fürsorge). Erich Böer. Discusses the problems of unemployment and describes a number of schemes for its relief. 6500 w. Schiffbau—May 12, 1909. No. 5772 D.

Wage Systems.

The Piece Work System. J. A. Gohen. Abstract of a paper describing operation of piece work system in railways, read before the Central Electric Railway Association. 1500 w. Elec Ry Jour—June 5, 1909. No. 5256.

MARINE AND NAVAL ENGINEERING.

British Navy.

The Naval Power of Great Britian and Supremacy on the Sea (Les Forces navales de la Grande-Bretagne et la Suprematie des Mers). E. Lignorelles. A comparison of the strength of naval powers. Ills. 3000 w. Génie Civil—May 1, 1909. No. 5731 D.

Bulkheads.

Notes on the Strength of Steel Watertight Bulkheads. Athole J. Murray. Considers the problem of finding the necessary size, character and end fixing of the stiffeners. Plates. 3300 w. Trans N-E Coast Inst of Engrs & Shipbldrs—May, 1909. No. 5607 N.

Capstans.

Capstan Rims (Ueber Spillkranzformen). E. Schmidt. A discussion of the most efficient shape. Ills. 2500 w. Schiffbau—May 26, 1909. No. 5773 D.

Communication.

Transmission of Intelligence on Steam Vessels. H. A. Hornor. Considers only the present means of interior communication for the safe manipulation of the vessel and accommodation of passengers, officers and crew. Ills. 8000 w. Jour Fr Inst—June, 1909. No. 5805 D.

Cruisers.

Official Report of Coal Consumption Tests of the New Scout Cruisers. Memoranda of coal consumption on the "Birmingham," "Chester" and "Salem." 800 w. Power—June 8, 1909. No. 5324.

Electric Power.

Electrical Installations for Transatlantic Liners. Albert H. Bridge. Gives illustrated particulars of the electrical installations on board the Mauretania. 4500 w. Elec Rev, N Y—June 12, 1909. No. 5479.

An Electrically Operated Rhine Boat (Elektrisch betriebenes Fährschiff für den Rhein). W. Kaemmerer. Describes a small vessel driven from accumulators. Ills. 1200 w. Zeitschr d Ver Deutscher Ing—May 15, 1909. No. 5962 D.

Engineers.

The Engineer in the U. S. Navy. George W. Melville. Address at the Washington convention. Also presentation addresses by Walter M. McFarland and Dr. C. D. Walcott. 3300 w. Jour Am Soc of Mech Engrs—June, 1909. No. 5843 F.

Gas Engines.

Gas Engine and Equipment for the Non-Magnetic Yacht "Carnegie." Jas. Craig, Jr. Describes a special four-cylinder vertical engine with 11 x 12 cylinder containing less than 500 lbs. of iron or steel and made of non-magnetic materials. 1100 w. Rudder—June, 1909. No. 5333 C.

Hydroplanes.

Experiments With Hydroplanes or Skimmers. Illustrated account of results obtained by Sir John Thornycroft. 1500 w. Sci Am—June 12, 1909. No. 5397.

Oil Engines.

See same title, under MECHANICAL ENGINEERING, COMBUSTION MOTORS.

Oil Fuel.

Oil vs. Coal as a Marine Fuel. G. P. Blackiston. Explains the conditions and the need of proper heating and burning appliances to make oil fuel successful, and claims decided advantages if properly used. Ills. 8000 w. Prac Engr—May 21, 1909. No. 5188 A.

Practical Oil Economy of the U. S. S. Rhode Island. M. S. Holloway. Description of methods by which remarkable economy was secured in cruise around the world. Ills. 2100 w. Jour Am Soc of Nav Engrs—May, 1909. No. 5436 H.

Propellers.

The Maximum Elementary Efficiencies as a Basis for the Construction of the Pitch of the Screw Propeller (Die maximalen elementaren Wirkungsgrade als Grundlag für die Konstruktion der Steigung der Schraubenpropeller). W. Helling. Ills. 3200 w. Schiffbau—May 12, 1909. No. 5771 D.

Salvage Vessels.

The French Submarine Salvage Boat Vulcain. Illustrated description of this specially designed vessel and its equipment. 500 w. Engr, Lond—June 11, 1909. No. 5633 A.

We supply copies of these articles. See page 887.

Ship Cleaning.

The Electric Scrubber. Description of an electro-magnetic device for cleaning ships bottoms, whereby a "hogging brush" is held firmly to the plates. Ills. 1350 w. Elec Rev, Lond—May 28, 1909. No. 5419 A.

Ship Design.

The Strength of Knees and Brackets on Beams and Stiffeners. Herman R. Hunt. An investigation of beams supported by knees at the ends. Tables and diagrams. 1500 w. Soc of Nav Archts & Marine Engrs, No. 7—June, 1909. No. 5681 N.

Some Experiments With Lightened Beam Brackets. R. Earle Anderson. Describes experiments made in connection with the design of torpedo-boat destroyers, stating results. Ills. 3000 w. Int Marine Engng—June, 1909. Serial. 1st part. No. 5213 C.

See also Bulkheads, under MARINE AND NAVAL ENGINEERING.

Ship Resistance.

The Resistance of Some Full Types of Vessels. Herbert C. Sadler. Gives results of experiments upon the resistance of vessels of full form. Diagrams. 1000 w. Soc of Nav Archts & Marine Engrs, No. 3—June, 1909. No. 5679 N.

Ship Stability.

Stability Tests of Ships at Sea (Festigkeitsversuche an Schiffen auf See). K. Beschoren. Describes methods and gives conclusions. Ills. 4500 w. Zeitschr d Ver Deutscher Ing—May 15, 1909. No. 5965 D.

Ship Suction.

Some Model Experiments on Suction of Vessels. D. W. Taylor. An account of experiments made at the Model Basin within the last year. Diagrams. 1200 w. Soc of Nav Archts & Marine Engrs. No. 1—June, 1909. No. 5677 N.

Steamboats.

Shallow-Draught River Steamers. C. E. Ward. Discusses in detail the peculiar character of river steamers, the hull, machinery and its performance, etc. Ills. 9600 w. Soc of Nav Archts & Marine Engrs, No. 4—June, 1909. No. 5810 N.

Shallow Draught Steamers for the Amazon. Illustrations and particulars of five vessels built to meet special conditions. 500 w. Engr, Lond—May 21, 1909. No. 5202 A.

New Hudson River Steamboat, Robert Fulton. Illustrated detailed description of this fine new river passenger steamer, which was built in record time. 6000 w. Naut Gaz—June 17, 1909. No. 5609.

New Passenger Steamer Hyak. H. Cole Estep. Brief illustrated description of a vessel for service on Puget Sound. 1500 w. Marine Rev—June, 1909. No. 5499.

Steam Boilers.

Replacing the Furnaces of Marine Boilers Under Unusual Difficulties. William Shoemaker. Prize paper. Illustrated description of work on a steamship in service on the Great Lakes. 700 w. Boiler Maker—June, 1909. No. 5456.

Steamships.

Development of the Transatlantic Steamship. Reviews the growth since 1840. Ills. 1600 w. Sci Am—June 19, 1909. No. 5583.

A New Type of Great Lake Ore Steamer. Day Allen Willey. Illustrated description of the "Hoover and Mason" as a type. 1500 w. Sci Am Sup—June 19, 1909. No. 5584.

The Orient Company's Australian Mail Liner "Otway." Illustrations, with description of this new twin-screw vessel and its machinery. 3300 w. Engng—June 4, 1909. No. 5528 A.

The New Orient Liners. Describes large passenger steamship "Orsova" and other ships constructed for Orient Mail line for Australian service. Ills. 2500 w. Engr, Lond—May 28, 1909. No. 5316 A.

The New Orient Australian Mail Liner "Orsova." Illustrated description of the first of four vessels designed for service between Europe and Australia. "Orsova" is of 15,100 tons displacement and 18 knots speed. Plates. 5200 w. Engng—May 28, 1909. No. 5260 A.

The "George Washington." Illustrated description of this new North German Lloyd steamer. 1600 w. Sci Am Sup—June 26, 1909. No. 5897.

Twin Screw Steel Steamship Columbian. Brief illustrated description of a cargo carrier in the Pacific trade. 700 w. Marine Rev—June, 1909. No. 5498.

Steam Turbines.

The Steam Turbine and the Reciprocating Engine for Marine Propulsion. Ira N. Hollis. This third article of a series gives a critical analysis of factors, results and tendencies. Ills. 2500 w. Engineering Magazine—July, 1909. No. 5978 B.

A Method of Determining Pressures for Steam-Turbines. C. H. Peabody. Gives a method of determining directly the pressures of a compound steam turbine, taking into account the increase of entropy due to steam friction. 2500 w. Soc of Nav Archts & Marine Engrs, No. 2—June, 1909. No. 5678 N.

The Operation and Management of the Parsons Marine Steam Turbine as Practiced on the U. S. S. Chester. Lieutenant A. F. H. Gates. Gives writer's experience in shops and at sea. Practical details of operation. Ills. 11300 w. Jour Am Soc Nav Engrs—May, 1909. No. 5435 H.

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Submarines

Underwater Torpedo Boats. Lawrence Spear. Historical review and full discussion of modern submarine and submersible boats. Ills. 22000 w. Jour Am Soc of Nav Engrs—May, 1909. No. 5433 H.

Submarine Signalling.

Submarine Signalling. Present development of methods. 1500 w. Jour Am Soc of Nav Engrs—May, 1909. No. 5434 H.

The Application of Electricity to Submarine Signalling. Discusses need of some electrical sounder for efficient submarine signalling. 2000 w. Elec Rev, Lond—May 28, 1909. No. 5420.

Towing.

Towing Problems. Thomas S. Kemble. On determining the requirements arising from given towing conditions, and the manner in which a towing machine and cable of given size will meet the requirements. Ills. & diagrams. 5000 w. Soc of Nav Archts & Marine Engrs, No. 8—June, 1909. No. 5683 N.

United States Navy.

The Fusion of the Line and Engineer Officers in the United States Navy (Il Corpo unico, la Fusione degli Ufficiala di Vascello e Macchinisti della Marina Nord-Americana). A. Levi Bianchini. An Italian opinion. 7000 w. Riv Marit—May, 1909. No. 5743 E + F.

Wave Pressures.

Lateral Wave Pressure on Ships (Einfluss des Wellendruckes auf die seitliche Schiffswand). Karl Beschören. A theoretical discussion. Ills. 3200 w. Schiffbau—May 26, 1909. No. 5774 D.

MECHANICAL ENGINEERING.

AUTOMOBILES.

Cabs.

Walter Christie's Front-Drive Autocab. Illustrated detailed description. 2800 w. Automobile—June 10, 1909. No. 5505.

Commercial Vehicles.

The International Commercial Vehicle Competition (Die internationale Motorlastwagen-Wettbewerb und die Subventionsfahrt der Verkehrstruppen). Describes the competing cars and gives results of the trials. Ills. Serial, 1st part. 3600 w. Zeitschr d Mit Motorwagen Ver—May 15, 1909. No. 5776 D.

Dust Problem.

Trapping the Insidious Dust. W. R. Cooper. An illustrated account of an investigation of the air currents about a motor car in motion. Read before the Royal Automobile Club. 2200 w. Auto Jour—May 22, 1909. No. 5183 A.

Electric.

Electric Automobile Motors and Controllers. Alex Churchward. Considers the design, types, method of control, &c. 1500 w. Elec Rev, N Y—June 12, 1909. No. 5480.

Exhibitions.

Historical Motor Cars. Description of an interesting collection of typical vehicles gathered for the Imperial International Exhibition at Shepherd's Bush. Ills. 2700 w. Motor Car Jour—May 29, 1909. No. 5438 A.

Farm Motors.

A Machine of Absorbing Interest to Farmers. Illustrated description of a "hay-buck," invented by Jacob E. Liebhart. The machine is propelled by an automobile engine, and may perform all its functions with the assistance of two men. 1200 w. Automobile—June 10, 1909. No. 5503.

Fuels.

Heat Values of Ordinary Automobile Fuels. Dr. Fritz Huth. Trans. from *Der Motorwagen.* Illustrated description of the Junker calorimeter and its use in determining the heat value of fuels. 1200 w. Automobile—June 10, 1909. No. 5504.

Garages.

The Automobile in the Garage (Das Automobil in der Garage). H. von Eicken. A discussion of garage location, equipment, etc. Ills. Serial, 1st part. 3600 w. Zeitschr d mit Motorwagen Ver—May 15' 1909. No. 5775 D.

Ignition.

Dual Ignition Systems and Switch Starting-Devices. Gives information about devices which supplement magnetos, and an illustrated description of the Bosch dual-ignition system. 2000 w. Auto Jour—May 22, 1909. Serial. 1st part. No. 5181 A.

Lighting.

Electric Lighting for Automobiles. Morris A. Hall. An illustrated account of the progress made in the use of electricity for car lighting. 1800 w. Automobile—June 3, 1909. No. 5231.

Motor Efficiency.

Thermal and Combustion Efficiency of a Motor. Prof W. Watson. Abstract of a paper giving results and deductions of a thorough test recently made. 3000 w. Automobile—June 10, 1909. No. 5501.

Motor Lubrication.

Lubrication of Gasoline Vehicle Motors. J. W. G. Brooker. From a paper

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before the Roy. Auto Club. A practical discussion. 3000 w. Com Veh—June, 1909. No. 5214 C.

Motor Rating.

The Computation of Engine Horse-Power Rating Formulae. Report of W. Worby Beaumont on horse-power rating and the present situation with regard to it. 4500 w. Engr, Lond—May 21, 1909. No. 5201 A.

Motors.

Exhaust side of Automobile Motors. Thomas J. Fay. The present number considers exhaust manifolds used in water-cooled motors. Ills. 1000 w. Automobile—June 10, 1909. Serial. 1st part. No. 5500.

Motor Testing.

Indicator Cards and What They Delineate. Thomas J. Fay. Analysis of indicator cards and to investigate automobile motors. 4500 w. Automobile—June 24, 1909. No 5881.

Repairs.

Kinks and Wrinkles for the Autoist. D. R. Hobart. Suggestions for emergencies and repairs during touring. 2500 w. Automobile—June 24, 1909. No. 5882.

What to Do When the Fuel Pipe Breaks. D. R. Hobart. Explains methods of temporarily repairing. Ills. 1500 w. Automobile—June 17, 1909. No. 5588.

Rolls-Royce.

Reliability and Refinement. Illustrates and describes the Rolls-Royce improvements for the year 1910. 2200 w. Auto Jour—June 12, 1909. Serial. 1st part. No. 5626 A.

Stanley.

Building the Stanley Steamer. Illustrates and describes interesting details of boilers and other features. 1500 w. Am Mach—Vol. 32. No. 23. No. 5385.

Talbot.

15 H. P. Four-Cylinder Talbot Car. Description of the 1909 model. Ills. 2300 w. Autocar—May 29, 1909. No. 5449 A.

Thomas.

A New 6-Cyl. Car from America. Illustrated description of the 40 H. P. Thomas flyer. 1200 w. Auto Jour—May 22, 1909. Serial. 1st part. No. 5182 A.

Tire Pressures.

Effect of Speed on Tire Pressures. Charles B. Hayward. Explains the effect when a tire punctures under ordinary and under high speed conditions. Ills. 2200 w. Automobile—June 10, 1909. No. 5502.

Tires.

Resilient Fillings for Tires. A. J. McKinney. A record of a series of investigations and experiments with solid fillings and compound tires. 3000 w. Autocar—June 12, 1909. No. 5639 A.

White.

White Cars for 1910 Include a Gasoline. Illustrates and describes the new features of the 1910 models; the most important being the modifications which make possible the use of kerosene or gasoline as fuel. 1500 w. Automobile—June 17, 1909. No. 5587.

COMBUSTION MOTORS.

Fuels.

The Denomination of Industrial Hydrocarbons (La Dénomination des Carbures d'Hydrogène employés dans l'Industrie). E. Lemaire. Discusses the chemical differences between the various motor fuels, etc. 2000 w. Génie Civil—May 15, 1909. No. 5740 D.

Gas Calorimetry.

Practical Determination of the Calorific Power of Gaseous Fuels (Détermination pratique du Pouvoir calorifique des Combustibles gazeux industriels). Georges Bourrey. Describes the Lemoult apparatus and method. Ills. 3000 w. Tech Mod—May, 1909. No. 5731 D.

Gas Engines.

The Internal Combustion Engine. J. Stanley Richmond. Reviews, chapter by chapter, a work written by H. E. Whimperis. 6500 w. Can Engr—June 18, 1909. No. 5610.

The Development of the Large Gas Engine. Abstract of the second part of Richard Bechtel's paper on "The Nurnberg Gas Engine." Deals with efficiency and cost of maintenance. Ills. 4000 w. Ir & Coal Trds Rev—June 11, 1909. No. 5664 A.

Introduction to the Theory of Explosion Motors (Introduction à l'Etablissement de la Théorie des Moteurs à Explosion). L. Letombe. A discussion of indicator diagrams. Ills. 3000 w. Tech Mod—May, 1909. No. 5732 D.

Gasoline Engine Testing.

The Testing of Petrol Engines. Jas. L. Miller. Read before the Glasgow Tech. College Sci. Soc. Explains the objects of the test and the method. 2000 w. Mech Engr—June 4, 1909. No. 5523 A.

Gas Power Plants.

Getting the Most Out of Gas Engines. E. G. Tilden. Describes experiments with a small gas engine plant to produce increased economy. Also a heater for exhaust gases and circulating water. Ills. 700 w. Power—June 8, 1909. No. 5327.

Good Record by a Suction Producer and Hit-and-Miss Engine. Wesley E. McArdell. Describes experience with a producer plant where the producer paid for itself in a year. 1400 w. Power—June 8, 1909. No. 5325.

The Largest Coke-Oven Gas Engine Plant. J. B. Von Brussel. Illustrates and describes how an up-to-date colliery

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is able economically to cover all its power requirements. 1000 w. Eng & Min Jour—June 12, 1909. No. 5478.

See also Central Stations, under ELECTRICAL ENGINEERING, GENERATING STATIONS; and Gas Power, under MINING AND METALLURGY, MINING.

Gas Producers.

On the Rate of Formation of Carbon Monoxide in Gas Producers. Describes investigations made in the Physical Laboratory of the University of Illinois. Ills. 5500 w. Univ of Ill, Bul. 30—Feb. 1, 1909. No. 5695 N.

The Suction Gas Producer. T. W. Burt. Explains the theory of producer gas, the general principles to be complied with and the methods in use. Ills. 5000 w. Cassier's Mag—June, 1909. No. 5540 B.

Morton's Suction Gas-Producer for Bituminous Fuel. Illustrated description. 1200 w. Engng—June 11, 1909. No. 5659 A.

The Westinghouse Double-Zone Bituminous Gas Producer. Illustrated detailed description, with report of tests. 3000 w. Ir Trd Rev—June 24, 1909. No. 5884.

The Westinghouse Double-Zone Bituminous Gas Producer. From the report of the Committee on gas engines of the Nat. Elec. Lgt. Assn. Illustrates and describes this type of plant and its operation. 3000 w. Ir Age—June 17, 1909. No. 5565.

Recent Producers for Bituminous Coal (Neuere Generatoren für bituminöse Brennstoffe). J. Gwosdz. A number of types are described. Ills. 2200 w. Glückauf—May 22, 1909. No. 5759 D.

Gas Turbines.

Gas Turbine Tests (Versuche an einer Petroleumturbine). Alfred Barbezat. Describes progress to date. 2500 w. Zeitschr f d Gesamte Turbinenwesen—May 19, 1909. No. 5780 D.

Oil Engines.

Crude Oil Engines for Land and Marine Purposes. Illustrated description of a new type of crude oil engine, built in Stamford, Eng. 1700 w. Engng—June 4, 1909. No. 5530 A.

HEATING AND COOLING.

Boilers.

See Boiler Design, under STEAM ENGINEERING.

Central Plants.

London Municipal Heat Supply. Alfred E. Wheeler. Discusses the advantages of central station heat generation, especially its relation to the prevention of smoke. 3000 w. Archt, Lond. June 4, 1909. Serial. 1st part. No. 5513 A.

Cooling Towers.

Design and Operation of Cooling Towers. M. R. Bump. Read before the Nat. Elec. Lgt. Assn. Compares the relative merits of natural and forced draft types. 3000 w. Power—June 22, 1909. No. 5813.

See also Condensers, under STEAM ENGINEERING.

Fans.

Notes on Fan Construction (Beispiele aus dem Gebiete des Ventilatorenbaues). Th. v. Bavier. Describes various types of fans and their use. Ills. 3500 w. Zeitschr d Ver Deutscher Ing—May 29, 1909. No. 5968 D.

Hospitals.

Warming and Ventilating with Special Reference to Hospital Buildings. D. D. Kimball. Reviews the history and development of the principles of ventilation, explaining methods of warming and ventilating hospitals. 3500 w. Br Build—May, 1909. Serial. 1st part. No. 5155 D.

Hot-Air Heating.

A Fan System of Church Heating in Solvay, N. Y. R. H. Bradley. Describes a fan pressure system of warm-air heating which is claimed to possess advantages over an indirect steam or hot-water gravity apparatus. Ills. 560 w. Met Work—June 5, 1909. No. 5362.

Hot-Water Heating.

The Determination of the Sizes of Pipes for Hot Water Heating. F. E. Giesecke. Explains a method of designing a pipe system to insure satisfactory results. 1800 w. Dom Engng—May 29, 1909. Serial. 1st part. No. 5151.

Accelerated Hot Water Heating Systems. Prof. Ed. Meier. Translation of a paper read before the Vienna Congress. Ills. 2500 w. Met Work—May 29, 1909. Serial. 1st part. No. 5153.

The Calculation of Pipe-Lines for Hot-Water-Heating (Die Berechnung der Rohrleitungen bei Warmwasserheizungen). M. Haller. A reply to Herr Rietschel. Ills. 3000 w. Gesundheits-Ing—May 8, 1909. No. 5797 D.

Plumbing.

Some Anomalies in Modern Plumbing Regulations. J. Pickering Putnam. A critical review of present plumbing conditions, with general discussion. Ills. 10000 w. Jour Assn of Engng Socs—April, 1909. No. 5839 C.

Prisons.

A New Method of Heating and Ventilating Prisons. John G. Eadie. Brief illustrated description of the method used at the new Riker's Island penitentiary. 800 w. Heat & Vent Mag—June, 1909. No. 5555.

Refrigeration.

Compression and Absorption Systems.

We supply copies of these articles. See page 887.

Their defence by rival manufacturers. Gives the papers of Thomas Shipley and of Heywood Cochran, presented at the Chicago meeting of the Illinois Ice Dealers. 10500 w. Ice & Cold Storage—June, 1909. No. 5464 A.

Refrigeration in Fruit Handling. G. Harold Powell. Extracts from a paper presented at International Congress of Refrigerating Industries at Paris. Describes American methods, construction of cars, etc. 3100 w. Ice & Refrig—June, 1909. No. 5446 C.

A Modern Poultry and Egg House. Describes an up-to-date poultry plant at Atchison, Kan. Ills. 3500 w. Ice & Refrig—June, 1909. No. 5443 C.

Refrigeration in the Hotel Anthony. Describes modern hotel plant with steel glass refrigerators, and a 20-ton ice plant at Fort Wayne, Ind. Ills. 1950 w. Ice & Refrig—June, 1909. No. 5445 C.

Temperature Recorders.

An Improvement in Heating and Ventilating. Royce W. Gilbert. Discusses the use of recording thermometers and hygrometers in ventilation. 4000 w. Ind Engng—June, 1909. No. 5800 C.

Ventilation.

Tables for Ventilating Ducts. Chouteau E. Pearce. Gives tables useful in rapidly estimating the area and weights of ducts usually employed. 500 w. Heat & Vent Mag—June, 1909. No. 5552.

Ventilating Scheme for a Hotel Building. Illustrates and describes the application of rectangular and round air ducts in Secor Hotel, Toledo, Ohio. 1200 w. Heat & Vent Mag—June, 1909. No. 5553.

Schoolhouse Ventilation in Switzerland (Lüftungseinrichtungen in schweizerischen Schulhäusern). Max Hottinger. Describes and discusses the systems in use. Ills. Serial, 1st part. 3000 w. Schweiz Bau—May 29, 1909. No. 5770 B.

See also Hospitals, under HEATING AND COOLING; and Mechanical Plants, under POWER AND TRANSMISSION.

HYDRAULIC MACHINERY.

Hydrodynamics.

Hydraulic Machinery. James W. Nelson. Deals with hydrostatics and hydrodynamics in their relation to machinery, especially some of the more common applications in the development and transmission of power. Ills. 14500 w. Pro Brooklyn Engrs' Club, No. 83—1908. No. 5874 F + F.

Piping.

Water Hammer in Pipe Lines (Les Coups de Bélier dans les Conduites d'Eeau). A. Rateau. A mathematical discussion of the stresses induced in pipe lines by the sudden closing of valves, etc. Ills. 7000 w. Bul Sci de l'Assn des Elèves—April, 1909. No. 5700 D.

Pumping Engines.

History of Pumping Engines. C. A. Hague. Illustrated lecture, reviewing the history since 1601. Discussion. 7000 w. Pro Am W-Wks Assn—1908. No. 5987 N.

High Duty vs. Low Duty Pumping Machinery. J. N. Chester. Considered from the operator's standpoint. Discussion. 7800 w. Pro Am W-Wks Assn—1908. No. 5988 N.

Superheating for Duty. E. H. Foster. Presents the advantages in using superheated steam in pumping engines. Ills. 1500 w. Am W-Wks Assn—June, 1909. No. 5917 N.

Tests of Modern High Duty Pumping Engines (Crank and Fly-Wheel Type) With and Without Superheated Steam. John Primrose. Reports tests of engines for Cincinnati, Ohio. 1000 w. Am W-Wks Assn—June, 1909. No. 5925 N.

Pumping Plants.

High Duty Pumping Records at North Point Pumping Station, Milwaukee, Wis. Cornelius T. Myers. Reviews the history of this pumping station and the progress made in the manufacture of pumping engines as there represented; also gives results. 3500 w. Am W-Wks Assn—June, 1909. No. 5905 N.

Boiler Equipment, Practice and Results at Pumping Station, Water Department, Harrisburg, Pa. George G. Kennedy. Brief description of a satisfactory plant. 1800 w. Am W-Wks Assn—June, 1909. No. 5914 N.

Pumps.

Suction, as Applied to Pumps. William Perry. Reviews the early history of suction pipes, explaining their action. 2000 w. Pro Am W-Wks Assn—1908. No. 5936 N.

A 42-inch Low Pressure Elevator Pump. Describes a pump run on the exhaust of electric light engines in a large retail establishment. Ills. 950 w. Power—June 8, 1909. No. 5318.

Surge Tanks.

The Surge Tower of the Turnwater Power Plant. Illustrated description of an interesting feature of the power plant at Turnwater Canyon, Washington, built to furnish electric power to operate trains through the Cascade tunnel. 2000 w. Eng Rec—June 12, 1909. No. 5483.

Turbine Plants.

See Surge Tanks, under HYDRAULIC MACHINERY.

Turbines.

The Basis of the Lorenz Turbine Theory (Die Grundlagen der Lorenzschen Theorie der Kreiselräder). R. Löwy. A mathematical explanation. Ills. Serial, 1st part. 2000 w. Zeitschr f d Gesamte Turbinenwesen—May 10, 1909. No. 5777 D.

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The Development of Multi-Stage Turbines (Die Entwicklung der mehrstufigen Wasser-Turbine). R. Löwy. A historical review, with notes on present development. Ills. 2800 w. Elektrotech u Maschinenbau—May 30, 1909. No. 5961 D.

Turbine Tests.

Tests of a Horizontal Francis Turbine (Versuche an einer dreifachen Horizontal-Francisturbine). Gives the results in a series of curves. Ills. 1800 w. Zeitschr f d Gesamte Turbinenwesen—May 29, 1909. No. 5782 D.

MACHINE ELEMENTS AND DESIGN.

Clutches.

Clutches. Thomas R. Shaw. An illustrated article dealing particularly with some of the clutches used in machine tools. 2800 w. Mech Engr—June 4, 1909. Serial, 1st part. No. 5522 A.

Drafting Machines.

Universal Drafting Machines of New Design. Illustrates and describes machines with ball-bearing joints and tubular rods. 1000 w. Am Mach—Vol. 32. No. 22. No. 5209.

Gears.

The Design of Worm Gearing. Considers the exact geometrical nature of worm gearing, and the causes of inefficiency in worm wheels, describing a method of designing worm teeth which will gear. 1200 w. Prac Engr—June 11, 1909. Serial. 1st part. No. 5629 A.

Speed of Spur Gears. Charles H. Loque. A discussion of the safe speed limit and how to determine it. 1500 w. Am Mach—Vol. 32. No. 22. No. 5210.

Steels for Gears. Louis P. M. Revillon. Abstract of report on research work during 1908-9. 1500 w. Mech Engr—May 21, 1909. No. 5190 A.

Journal Bearings.

Relation Between Rotative Speed and Bearing Surface of Journal Bearings. A. M. Bennett. Gives formula and graphical chart for bearings under a steady load. 900 w. Am Mach—Vol. 32. No. 24. No. 557'.

Keys.

Square Machine Keys. O. V. Thiele. Indicates features worth further investigation. 2500 w. Wis Engr—April, 1909. No. 5688 D.

Mechanics.

Inertia and Mass. V. Dwelshouvers-Dery. Reviews the theories of modern physicists, and presents arguments to show that it has not been demonstrated that the material mass of bodies is variable. 3500 w. Engng—June 11, 1909. No. 5662 A.

Slide Rules.

The Slide Rule and Logarithm Chart. O. B. Poore. Discusses the relations and the possible application of the chart and rule to engineering problems. 1500 w. Minn Engr—May, 1909. No. 5563 C.

A Slide Rule for Calculating Helical Springs. Winslow H. Herschel. An explanation of the use of a special rule resulting in saving of time in making calculations. 2800 w. Harvard Engng Jour—June, 1909. No. 5992 D.

Speed Changing.

Reversing and Speed Changing Devices (Quelques Changements de Marche et de Vitesse). A review of recent inventions in this field. Ills. 6000 w. Rev de Mécan—May, 1909. No. 5708 E + F.

Springs.

See Slide Rules, under MACHINE ELEMENTS AND DESIGNS.

Wedges.

Friction and Abrasion Tests on Steel Wedges. J. S. Macgregor. A report of test made at Columbia Univ. testing laboratory on Hawk brand hardened-steel wedges. 1800 w. Am Mach—Vol. 32. No. 25. No. 5861.

MACHINE WORKS AND FOUNDRIES.

Annealing.

See Pyrometry, under MEASUREMENT.

Boiler Making.

International Master Boiler Makers' Association. Account of proceedings of Annual Convention at Louisville, Ky., with abstracts of papers and discussion. Ills. 21000 w. Boiler Maker—June, 1909. No. 5439.

Standardizing of Pipe Flanges for Boilers and Templets for Drilling Same. James Crombie. Abstract of report presented to International Boiler Makers Ass'n, which describes and discusses existing standards. 2300 w. Boiler Maker—June, 1909. No. 5455.

Brass Founding.

Melting Brass Turnings in the Oil Furnace. Edward H. McVeen. Paper read before the American Brass Founders' Ass'n describing the use of the oil furnace for making light and medium heavy brass castings. 650 w. Foundry—June, 1909. No. 5360.

Bronze Founding.

The Casting of Bronze Statues. Snowden B. Redfield. Describes the intricate core work necessary. 3000 w. Am Mach—Vol. 32. No. 22. No. 5208.

Buildings.

See Factories, under CIVIL ENGINEERING, CONSTRUCTION.

Case Hardening.

The Cementation of Iron and its Alloys by Carbon Monoxide (Sur la Cémentation du Fer et de ses Alliages par l'Oxyde de Carbone). M. G. Charpy. Suggests a new method for case hardening. 6500 w. Rev de Métal—May, 1909. No. 5721 E + F.

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Castings.

The Relation of Engineering Design to Foundry Manufacture of Cast Iron Forms. W. R. Conrad. Calls attention to the manner in which iron will act in being cast, and its relation to design. 1500 w. Pro Am W-Wks Assn—1908. No. 5941 N.

Cost of Steel Making in Foundries. Bradley Stoughton. Read before the Am. Found. Assn; Considers the future relation of electric steel making processes to present methods. 2500 w. Ir Trd Rev—June 10, 1909. No. 5365.

Steel Castings. Otto Beckmann. Explains the system of producing various types of castings. Ills. 2500 w. Ir & Coal Trds Rev—May 14, 1909. No. 5141 A.

The Production of Castings for Agricultural Machinery (Die Herstellung der Gussstücke für den landwirtschaftlichen Maschinenbau). R. Schmidt. Outlines the special problems of this class of work. Ills. Serial, 1st part. 1500 w. Giesserei-Zeit—May 1, 1909. No. 5762 D.

Converters.

The Small Bessemer Converter. P. Eyermann. Detailed description of its use in the manufacture of steel castings in Belgium. Ills. 1200 w. Ir Age—June 24, 1909. No. 5858.

Cupola Gases.

The Mass and Chemical Composition of Cupola Waste Gases (Menge und chemische Zusammensetzung der Kupolofengichtgase). Georg Buzek. A discussion of the effect of the air supply. 2100 w. Stahl u Eisen—May 12, 1909. No. 5748 D.

Cupola Practice.

The Continuous Running of Cupolas. Walter J. May. Suggestions for this method of working. 1200 w. Prac Engr—June 11, 1909. No. 5628 A.

Cutting Metals.

Oxhydric Process of Cutting Metals. E. F. Lake. Illustrates and describes this method, the apparatus used, and some applications. 3000 w. Am Mach—Vol. 32. No. 25. No. 5860.

The Resistance of Metals to Cutting by the Removal of Small Chips (Ueber den Schnittwiderstand bei der Bearbeitung der Metall durch Abheben von Spänen). H. Friedrich. Reviews various tests and theories. Ills. 5500 w. Zeitschr d Ver Deutscher Ing—May 29, 1909. No. 5969 D.

Cutting Tools.

Relation of Cutting Speed, Feed, Depth of Cut. Edward G. Herbert. Investigates wear in cutting tools, with explanation of Herbert's Cube law. 2500 w. Am Mach—Vol. 32. No. 25. No. 5862.

Drilling.

High Speed Twist Drills. Discusses the use of drills in a railway shop and gives tables showing the best speeds and feeds for different size drills. 2000 w. Am & Engr R. R. Jour—June, 1909. No. 5336 C.

Drilling Machines.

The Improved Western Radial Drill. Illustrated detailed description. 1500 w. Ir Age—June 3, 1909. No. 5222.

26-in. High-Speed All-Geared Drilling Machine. Illustrated description of a British design, embodying the most recent improvements. 700 w. Engng—May 28, 1909. No. 5364 A.

Increasing the Efficiency of a Horizontal Drilling, Tapping and Boring Machine. Alfred Spangenberg. Illustrates features recently added. 1200 w. Mach, N Y—June, 1909. No. 5175 C.

Files.

An Investigation of the Efficiency of Files. Edward C. Herbert. Describes recent investigations of the relative efficiency of files of various types. Ills. 4000 w. Am Mach—Vol. 32. No. 22. No. 5212.

Forging.

See Steam Hammers, under MACHINE WORKS AND FOUNDRIES.

Foundry Appliances.

A Novel Power-Ramming Machine. Describes a machine where sand is conveyed from the heap by an elevator belt to a screw from which it is directed on to a packer belt into the flask. Ills. 1000 w. Foundry—June, 1909. No. 5354.

Foundry Furnaces.

See Brass Founding, under MACHINE WORKS AND FOUNDRIES.

Foundry Practice.

The Foundry in Its Relation to Chemical Engineering. James Aston. Briefly considers the improved methods being introduced in foundry practice. 1000 w. Wis Engr—June, 1909. No. 5692 D.

Furnaces.

See Fuel Oil, under STEAM ENGINEERING.

Gear Cutting.

Machine Cut Helical Gears. Describes gear wheels which can be cut up to a diameter of 20 ft. and 3 ft. breadth. Ills. 900 w. Ir & Coal Trds Rev.—May 28, 1909. No. 5411 A.

Lathes.

An Unusual Turret Lathe Equipment. C. L. Goodrich. Illustrates and describes the methods and special tools used for machining joints, valves, valve-seats and connections. 1200 w. Am Mach—Vol. 32. No. 23, No. 5264.

Machine Tools.

Special Tools for Machining Cylinders. Claude Aiken. Illustrates and de-

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scribes different styles of machines, in which as many as five seperate operations may be in progress at one time. 1000 w. Am Mach—Vol. 32. No. 24. No. 5570.

Molding.

Molding and Casting (Formen und Giessen). Theodore Löhe. A discussion of practical points. Ills. Serial, 1st part. 1500 w. Giesserei-Zeit—May 1, 1909. No. 5763 D.

See also Foundry Appliances, under MACHINE WORKS AND FOUNDRIES.

Planers.

The Powell High Speed Accelerating Cut Planer. Illustrated description of a new type equipped with a mechanism for accelerating the speed. 1500 w. Ir Age—June 17, 1909. No. 5564.

Pneumatic Tools.

Care of Pneumatic Carving Tools. W. H. Van Sickle. Directions for Keeping them in proper condition. 1000 w. Compressed Air—June, 1909. No. 5608.

Press Tools.

Press Tools. W. E. Etheridge. Description of tools used for dynamo and switch gear manufacture. A paper read before Siemens Stafford Engineering Society. Ills. 2700 w. Mech Wld—May 28, 1909. No. 5442 A.

Safety Valves.

Safety Valve Discussion. Continued from the February meeting. 6000 w. Jour Am Soc of Mech Engrs—June, 1909. No. 5847 F.

Saws.

The Hot-Saw as a Cutoff Machine. H. Terhune. Illustrates and describes this machine and some of its work. 1000 w. Am Mach—Vol. 32. No. 23. No. 5352.

Shop Appliances.

Machines and Tools for Automobile Manufacture. C. B. Owen. States the requirements and conditions under which motor cars operate and the effect on tool design, as carried out in the factory of the Cadillac Co., Detroit, Mich. Ills. 3500 w. Mach, N Y—June, 1909. No. 5176 C.

Jigs and Tools for Machining Petrol-Engine Cylinders. T. Alex. Borthwick. Reviews some of the methods successfully adopted and the tools used. Ills. 2000 w. Mech Wld—May 28, 1909. No. 5457 A.

Knurls and Knurling Operations. Douglas T. Hamilton. An illustrated review of tools and appliances necessary for knurling, with formulae and data. 2000 w. Mach, N Y—June, 1909. Serial, 1st part. No. 5174 C.

Shop Cooling.

The Cooling of Factories by the Evaporation of water (Refraichissement des Lecaur industriels par Evaporation d'Eau). A. Papin. Describes methods and apparatus. Ills. 5500 w. Génie Civil—May 1, 1909. No. 5737 D.

Shop Heating.

The Choice of Heating Equipment for Manufacturing Plants. G. W. Stanton. Describes the various types of heating systems, explaining the conditions for which such is adapted. 3500 w. Engineering Magazine—July, 1909. No. 5974 B.

Shop Leasing.

Tenant Mills, Charles C. Klein. The first of a series of articles giving information relating to this class of manufactories. The present article deals with their origin and some of the features of construction. 2000 w. Ind Engng—June, 1909. Serial. 1st part. No. 5698 C.

Shop Lighting.

Standards of Illumination for Manufacturing Plants. H. Thurston Owens. The qualities, advantages, and limitations of various systems are considered. Ills. 2000 w. Engineering Magazine—July, 1909. No. 5979 B.

Shop Practice.

Machine-Tool Pratice for Maximum Production. Charles Day. First of a series of six articles discussing the principles of machine-shop practice for maximum production. Ills. 3500 w. Engineering Magazine—July, 1909. No. 5994 B.

The Manufacture of Piston Rings. James McIntosh. Suggestions, describing methods. 1500 w. Mach, N Y—June, 1909. No. 5178 C.

Snap Piston Rings and Their Making. F. A. Halsey. Describes the making of rings to fit the cylinders when new, and gives a scale of proportions. 1500 w. Am Mach—Vol. 32. No. 22. No. 5211.

Machining Heavy Connecting Rods. Allan Jenkins (Prize paper.) Illustrated description of the method used. 3000 w. Mech Wld—June 11, 1909. No. 5641 A.

Manufacturing Multiple-Spindle Screw Machines. Illustrated description of the plant and products of the National Acme Mfg. Co., Cleveland, Ohio. 5000 w. Ind Engng—June, 1909. No. 5697 C.

Some Points on Marking-Off. W. Burns. Suggestions in marking-off for machining. 1200 w. Mech Wld—June 4, 1909. No. 5521 A.

Shops.

The Phoenix Iron Works of Hartford. E. A. Dixie. Illustrates and describes machine tools built in these old works, with something of the history and methods of the works. 2500 w. Am Mach—Vol. 32. No. 24. No. 5569.

Small Arms and Machine Tool Works. Illustrated detailed description of this department of the St. John's Engineering Works at Erith. 2500 w. Engr, Lond—June 4, 1909. No. 5532 A.

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The Cail Works at Denain (Les Ateliers Cail à Denain). Louis Le Chatelier. Illustrated description of these locomotive works. 8500 w. Rev de Métal—May, 1909. No. 5725 E + F.

Steam Hammers.

Power Hammers and Forging Appliances. James Cran. Calls attention to points needing improvement in steam hammers, and to matters relating to this class of machinery Ills. 4000 w. Mach, N Y—June, 1909. No. 5177 C.

Welding.

Arc Welding. C. B. Aull. Describes briefly other processes of electric welding, as introductory to a detailed description of the Benardos. or arc welding process. Discusssion. Ills. 7000 w. Pro Engrs' Soc of W Penn—May, 1909. No. 5804 D.

Electric Welding. Abstract of paper by V. D. Green before Birmingham and District Electric Club which discusses various forms of welders. 2000 w. Mech Engr—May 28, 1909. No. 5403 A.

Welding and Brazing (Das Schweissen und Hartlöten). Discusses materials, processes, tests of product, etc. Ills. 2500 w. Stahl u Eisen—May 26, 1909. No. 5751 D.

MATERIALS OF CONSTRUCTION.

Alloys.

I. Monel Metal. Dr. A. Stansfield. II. Report on Tests of Monel Metals. Prof. E. Brown. Two papers discussed together. Ills. The papers deal with the metallurgy and physical properties of this product. 8000 w. Can Soc of Civ Engrs, Bul. 5—May, 1909. No. 5855 N.

Special Copper Alloys (Les Alliages de Cuivre spéciaux). Jean Escard. Discusses bronzes and brasses containing manganese, silicon, chromium, tungsten and vanadium. Ills. Serial. 1st part. 3000 w. Génie Civil—May 22, 1909. No. 5741 D.

Alloy Steels.

High-Tension Steels. Percy Longmuir. Read before the I. and S. Inst. Gives results of experiments made with a view to deciding on the most serviceable type of steel for high-tension and endurance purposes. 2500 w. Ir & Coal Trds Rev—May 14, 1909. No. 5130 A.

Notes on Properties of Steel Alloys and Steels. Gordon Surr. Discusses the influence of alloy elements. 3000 w. Min Wld—June 19, 1909. No. 5672.

An Investigation of Tantalum Steels. A detailed report of the experiments, with micrographs. 2500 w. Ir & Coal Trds Rev—June 11, 1909. No. 5665 A.

Manganese Steel (L'Acier au Manganèse). A letter from Schneider & Co. taking exception to a recent article on manganese-steel rails in *The Iron Age*, and a description of results obtained by this firm. Ills. 6000 w. Rev de Métal—May, 1909. No. 5724 E + F.

See also Gears, under MACHINE ELEMENTS AND DESIGN.

Cast Iron.

The Distribution of the Impurities in Cast Iron (Ueber die Verteilung der Fremdkörper im Gusseisen). Max Orthey. Results of an experimental study. Serial, 1st part. 1500 w. Giesserei-Zeit —May 1, 1909. No. 5761 D.

Lead.

Experiments on the Tempering of Lead and the Corresponding Changes in Hardness (Quelques Expériences sur la Trempe du Plomb et les Changements corrélatifs de sa Dureté). M. Loutchinnsky. Gives the results of tests. Ills. 2000 w. Rev de Métal—May, 1909. No. 5723 E + F.

Metallography.

See Alloys, under MINING AND METALLURGY, MISCELLANY.

Solders.

Solders and Fusible Alloys. H. F. Blake. Gives the composition and melting point of the most generally used solders and information relating to them. 1200 w. Am Mach—Vol. 32. No. 23. No. 5388.

Steel.

A Heat Treatment Study of Bessemer Steels. Andrew McWilliam and Ernest J. Barnes. Read before the I. and S. Inst. An account of investigations carried out at Sheffield University, Eng. 5000 w. Ir & Coal Trds Rev—May 14, 1909. No. 5127 A.

The Ageing of Mild Steel and the Influence of Nitrogen. C. E. Stromeyer. Read before the I. and S. Inst. A report of research work in regard to failures in steel. 4500 w. Ir & Coal Trds Rev—May 14, 1909. No. 5128 A.

The Chemical Physics Involved in the Decarburization of Iron-Carbon Alloys. W. H. Hatfield. Read before the I. and S. Inst. Reviews briefly the experimental work reported by different investigators, describing the writer's experiments and stating results. Ills. 3500 w. Ir & Coal Trds Rev—May 14, 1909. No. 5129 A.

Influence of the Treatment on the Solubility of Steel in Sulphuric Acid, and Deductions Therefrom as to the Nature of the Treatment to Which the Material Has Been Previously Subjected. E. Heyn and O. Bauer. (Abstract). Read before the I. and S. Inst. Ills. 6000 w. Ir & Coal Trds Rev—May 14, 1909. No. 5137 A.

Tool Steels.

The Newer High-Speed Steels. O. M. Becker. Gives the composition of re-

cent tool steels, explaining their lasting qualities and usefulness. 1500 w. Mach, N Y—June, 1909. No. 5179 C.

Wire Rope.

The Application of Wire Rope to Transportation. Discusses the systems in use, with notes on the care and types of wire rope. 8500 w. Ind Engng—June, 1909. No. 5699 C.

MEASUREMENT.

Gages.

Gages and Interchangeability in Small Scale Manufacture. F. A. Halsey. Illustrates and describes applications of the indicating caliper, explaining its advantages. 1500 w. Am Mach—Vol. 32. No. 23. No. 5384.

Hardness.

Notes on Tests for Hardness. Prof. Thomas Turner. Read before the I. and S. Inst. Compares four typical methods of measuring hardness, showing further research is required before agreement in principle can be reached. 3500 w. Ir & Coal Trds Rev—May 14, 1909. No. 5131 A.

The Analysis of Steel by Mechanical Means. A. F. Shore. Describes methods and the use of the scleroscope, explaining what it measures. 3500 w. Am Mach—Vol. 32. No. 25. No. 5863.

The Hardness of Metals and its Measurement in Cold and Heated Specimens (La Dureté des Métaux sa Mesure à Chaud et à Froid). Félix Robin. A review of methods and data of the results of investigation of various metals and alloys. Ills. 8000 w. Mem Soc Ing Civ de France—April, 1909. No. 5710 G.

Hydraulic Pressure.

Apparatus for the Measurement of High Hydraulic Pressure (Apparate zur Messung hoher Flüssigkeitsdrücke). A. Martens. Describes and discusses various types. Ills. 2200 w. Zeitschr d Ver Deutscher Ing—May 8, 1909. No. 5959 D.

Pyrometry.

Pyrometry in the Annealing Room. S. H. Stupakoff. Reviews various high-temperature measuring instruments and their applications, especially the use of pyrometers in annealing malleable iron. 8000 w. Am Found Assn—June, 1909. No. 5604 N.

The Bristol Recording Pyrometer. Percy Longmuir and T. Swinden. Read before the I. and S. Inst. Reports a test made to ascertain the behavior of the pyrometer under normal works conditions. 2000 w. Ir & Coal Trds Rev—May 14, 1909. No. 5136 A.

Testing Machines.

300-Ton Universal Testing Machine. Illustrated description of a large machine recently installed in the laboratory of the new university at Birmingham, Eng. 1800 w. Engr, Lond—May 21, 1909. No. 5200 A.

Thermometry.

Modern Methods of Temperature Measurement. Joseph H. Hart. Reviews some of the practical applications of thermometry. 2200 w. Cassier's Mag—June, 1909. No. 5538 B.

POWER AND TRANSMISSION.

Air Compressors.

Portable Air-Compressors. Illustrates and describes a type built in England. 900 w. Engng—June 11, 1909. No. 5658 A.

Air Compressor for South Africa. Illustrates and describes one of the largest enclosed-type air-compressing plants ever made. 1500 w. Engr, Lond—May 21, 1909. No. 5199 A.

Electric Driving.

An Electrically Driven Paper Mill. Describes the plant for a mill on the banks of the Tyne, England. 2500 w. Engr, Lond—June 11, 1909. No. 5638 A.

Electric Driving in a Paper Mill. Discusses the economy of electric driving in paper mills where steam is largely produced for heating and boiling and describes an English plant so equipped. Ills. 950 w. Elec Rev, Lond—May 28, 1909. No. 5417 A.

Electric Power.

Electrical Accidents in Workshops. Information from report of G. Scott Ram, bearing upon the peculiar risks and dangers due to using electric power. 5500 w. Mech Engr—June 11, 1909. No. 5640 A.

Gas Compressors.

High Pressure Gas Transmission. Describes steam driven compressor for high pressure gas transmission in country towns. Ills. 800 w. Can Engr—June 4, 1909. No. 5391.

Gas Power.

The Value of Gas Power. Charles E. Lucke. An illustrated article giving information on characteristics of the gas power installations, cost, etc. 5500 w. Sch of Mines Qr—April, 1909. No. 5898 D.

Mechanical Plants.

The Cleveland Technical High School. H. W. Woodward. Illustrated description of the heating, lighting, power and ventilating systems in this $400,000 building. 3000 w. Power—June 1, 1909. No. 5172.

Heating and Ventilating the National City Bank, New York. Illustrates and describes the mechanical equipment of this building. 1500 w. Heat & Vent Mag—June, 1909. No. 5554.

Power Plants.

Comparative Efficiencies of Power

We supply copies of these articles. See page 887.

Plants, With Special Reference to the Efficiency of a Superheated Steam Pipe-Line. Frank R. Brownlee. An account of investigations made. 5000 w. Wis Engr—June, 1909. No. 5691 D.

The New Keystone Watch Case Co. Plant. F. L. Johnson. Illustrated account of how an old plant was remodeled without interrupting the service. 2500 w. Power—June 15, 1909. No. 5492.

Power Equipment of the Bellman Brook Bleachery. Describes a model plant for the bleaching of fine cotton goods at Fairview, N. J. Ills. 3500 w. Eng Rec—June 5, 1909. No. 5284.

Turbo-Compressors.

Turbo - Blowers. C. Regenbogen. Trans. from *Stahl und Eisen*. Reviews progress in Germany with turbine driven rotary air compressors for blast furnace service. Ills. 4500 w. Ir Age—June 10, 1909. No. 5507.

STEAM ENGINEERING.

Ash Handling.

See Conveyors, under TRANSPORTING AND CONVEYING.

Boiler Corrosion.

Boiler Corrosion as an Electrochemical Action. C. F. Burgess. Discusses corrosion in steam boilers and the possibility of its being due to electrolytic action. General discussion. Ills. 6000 w. Jour W Soc of Engrs—June, 1909. No. 5878 D.

Boiler Design.

Propositions and Power of Low-Pressure Heating Boilers. Discusses the effect of restricting the grate area, suitable draft, &c. 2000 w. Dom Engng—June 12, 1909. No. 5511.

Best Method of Staying the Front Portion of Crown Sheet (in Radiat Stay Boilers) to Prevent Cracking of the Tube Sheet. Abstract of a committee report presented at meeting of Int. Master Boiler Makers' Assn. Gives recommendations. 800 w. Eng News—June 3, 1909. No. 5216.

Boiler Explosions.

Boiler Explosions in England, Germany, and the United States. Gives a comparison of statistics showing the United States to be far behind in the safe use of high-pressure steam. 2000 w. Locomotive—April, 1909. No. 5544.

Boiler Inspection.

Inspection for New York's Low Pressure Boilers. A. C. Rousey. Discusses dangers of so-called low power plants and methods proposed for removing them. 2900 w. Power—June 8, 1909. No. 5321.

Boiler Management.

Modern Boiler Practice. John W. Hill. Explains present practice, dealing only with standard types. 5500 w. Am W—Wks Assn—June, 1909. No. 5906 N.

Care and Management of the Horizontal Tubular Boiler. William Kavanagh. Directions for proper handling to secure economy and reliability. Ills. 1500 w. Power—June 15, 1909. No. 5493.

An Experience in the Boiler Room of a Water Works. Walter L. Watson. Outlines the comparative results obtained with natural draft, and with the "Balanced Draft System of Furnace Regulation," describing this system. Discussion. 3000 w. Pro Am W-Wks Assn—1908. No. 5938 N.

Boiler Rating.

The Rating of Domestic Heating Boilers. Konrad Meier. Discusses the fair rating of boilers, and matters related. 2000 w. Met Work—May 29, 1909. No. 5154.

Boilers.

See Pumping, under HYDRAULIC MACHINERY.

Boiler Scale.

The Prevention and Removal of Boiler Scale. W. H. Wakeman. First instalment of a series of papers on the methods to avoid the formation of scale in a boiler. Ills. 1800 w. Elec Wld—June 3, 1909. No. 5275.

Boiler Testing.

Boiler-Room Symposium. Jay M. Whitham. Principally a discussion of boiler testing. 2500 w. Am W-Wks Assn—June, 1909. No. 5915 N.

Evaporation Tests (Essais de Vaporisation). Victor Lebeau. Details tests on a B. & W. boiler to determine the most economical fuel. Ills. 12000 w. All Indus—May, 1909. No. 5733 D.

Boiler Tubes.

The Influence of Operation, Diameter and Profile on the Distortion of Boiler Fire Tubes (Einfluss des Betriebes, Durchmessers und Profiles auf die Formänderung von Flammrohren). Bruno Müller. Mathematical discussion of stresses in boiler tubes. Ills. 4000 w. Zeitschr d Ver Deutscher Ing—May 15, 1909. No. 5964 D.

Boiler Waters.

The Boiler Water. Edward Bartow. The troubles caused by water and the remedies are considered. 2500 w. Am W-Wks Assn—June, 1909. No. 5916 N.

Water Supply and Treatment for Power Plant Purposes. William Miller Booth. Gives a classification of waters, their characteristics and treatment required. 4500 w. Am W-Wks Assn—June, 1909. No. 5927 N.

Scaling and Corroding Substances and Their Elimination from Water for Boilers. J. C. William Greth. Abstract of a paper before the Scranton Engrs' Club. Considers the harmful substances in solution in waters. 1500 w. Power—June 22, 1909. No. 5812.

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Condensers.

Steam Condenser Design and Practice. Dr. Joseph H. Hart. An illustrated explanation of the characteristics, management and efficiency of various types. 2000 w. Engineering Magazine—July, 1909. No. 5976 B.

Design of Condenser and Cooling Tower Plants. Abstract of a paper by M. R. Bump before National Electric Light Association, which discusses the fundamental features of condensing plants. 3500 w. Eng Rec—June 5, 1909. No. 5280.

Development of the Surface Condenser. George A. Orrok. Gives an account of the surface condenser before and after the advent of the steam turbine. Ills. 4500 w. Power—June 1, 1909. No. 5173.

Engine Flywheels.

Variation in Angular Velocity of Fly-Wheels. Alex. R. Horne. Describes a method of determining the variation in angular velocity and the angular lag and lead of an engine fly-wheel from the diagram of crank effort by means of a planimeter. 1500 w. Engng—May 28, 1909. No. 5363 A.

Engine Foundations.

See Foundations, under CIVIL ENGINEERING, CONSTRUCTION.

Engine Management.

See Isolated Plants, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Engines.

Economy of Four Valve Engines. Thomas Hall. A defense of this type, with criticism by F. W. Dean. 3000 w. Power—June 22, 1909. No. 5814.

See also Pumping Engines, under HYDRAULIC MACHINERY.

Engine Tests.

Tests on a Wolf Compound-Tandem, Semi-Portable Engine with Superheater (Essais exécutés sur une nouvelle mi-fixe compound-tandem à Surchauffe, la Maison R. Wolf). Herr Gutermuth. Translation from *Zeitschr. d. Ver. Deutscher Ing.* Ills. 2300 w. Rev,. de Mécan—May, 1909. No. 5707 E + F.

Flue-Gas Analysis.

Formulas for Computing the Results of Gas Analysis. Frank B. Shields. Gives formulae for caluculations of results of analyses of chimney gases. 600 w. Power—June 22, 1909. No. 5817.

Real Relation of CO_2 to Chimney Losses. James E. Steely. Shows the lack of reliability in determining chimney losses without considering hydrogen, CO, and moisture. 2700 w. Power—June 8, 1909. No. 5323.

Fuel Oil.

Fuel Economy Tests. Discussion of paper by C. R. Weymouth. 2800 w. Jour Am Soc of Mech Engrs—June, 1909. No. 5845 F.

Oil Furnaces and the Economical Handling of Oil as Fuel. Jno. E. Ulrich. Considers the methods of atomizing the oil, the construction of the furnaces and the economy. 2500 w. Ir Trd Rev—June 3, 1909. No. 5230.

See also Oil Fuel, under MARINE AND NAVAL ENGINEERING.

Fuels.

Some Industrial Applications of Pulverized Coal. William D. Ennis. Discusses its preparation, handling, applications, difficulties, &c. Discussion. 14000 w. Pro Brooklyn Engrs' Club, No. 81—1908. No. 5872 F + F.

Coals for Hand-Fired Steam Plants. D. T. Randall. Reports results of tests that show that almost any character of coal may be burned with reasonable efficiency. Diagrams. 1500 w. Am W-Wks Assn—June, 1909. No. 5911 N.

The Purchase of Fuel on a British Thermal Unit Basis. Lawrence P. Crecelius. Explains the method adopted in Cleveland, Ohio, of purchasing coal on the basis of calorific value. 4000 w. Pro Am Inst of Elec Engrs—June, 1909. No. 5838 F.

The Purchase of Coal Upon a Heat Value Contract. Edward H. Taylor. Considers the causes that have led to the purchase of coal upon specifications, the contract, and related subjects. 18000 w. Am W-Wks Assn—June, 1909. No. 5928 N.

See also Peat, under MINING AND METALLURGY, COAL AND COKE.

Injectors.

The Working Process in Injectors (Untersuchungen über den Arbeitsvorgang im Injektor). G. Schrauff. Describes and gives results of elaborate tests. Ills. Serial, 1st part. 6000 w. Zeitschr d Ver Deutscher Ing—May 15, 1909. No. 5963 D.

Piston Rings.

Piston Packing Rings. James Andrews. Abstract of paper before the W. of Scotland Assn. of Foremen Engrs. Shows that the same packing rings do not behave alike in all cases, and discusses the principle of their action. Ills. 3500 w. Mech Wld—June 4, 1909. Serial. 1st part. No. 5520 A.

Safety Valves.

Auld's Safety Valves for Low Pressure. Describes two designs of new safety valves more particularly adapted for low pressure steam. Ills. 950 w. Mech Engr—May 28, 1909. No. 5402 A.

Smoke Prevention.

Smoke Prevention or Smoke Consumption. Harold V. Coes. This second article of a serial discusses automatic

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stokers, describing leading types. Ills. 5500 w. Engineering Magazine—July, 1909. No. 5972 B.

The Smokeless Combustion of Coal in Boiler Plants, with a Chapter on Central Heating Plants. D. T. Randall and H. W. Weeks. States the problem and discusses its solution. Ills. 30000 w. U S Geol Survey—Bul. 373. No. 5696 N.

Smoke Prevention. D. T. Randall. Paper read at Syracuse meeting of the Int. Assn. for Prevention of Smoke. Discusses the relation of the character of coals to the prevention of smoke. 1800 w. Sci Am Sup—June 26, 1909. No. 5896.

Smoke and Smoke Prevention. L. P. Breckenridge. Reviews the principles of smokeless combustion, discusses furnaces, their construction and operation. Ills. 8500 w. Am W-Wks Assn—June, 1909. No. 5921 N.

Smoke Abatement. Sir William B. Richmond. Remarks on the damage caused by smoke, introductory to a discussion. 5000 w. Jour Roy Inst of Brit Archts—May 22, 1909. No. 5594 C.

Rules for Smokeless Consumption of Fuel. Robert Grimshaw. Discussion of rules laid down by the "Magdeburger Verein für Dampfkesaelbetrieb." 1300 w. Eng & Min Jour—June 5, 1909. No. 5304.

Steam Compression.

The Application of the Compression of Steam to the Evaporation of Industrial Liquids (Application de la Compression de la Vapeur à l'Evaporation des Liquides industriels). Ch. Prache and Ch. Bouillon. A discussion of practice. Ills. 8800 w. Mem Soc Ing Civ de France—April, 1909. No. 5712 G.

The Compression of Steam and Its Application to Evaporation (De la Compression de la Vapeur appliquée à l'Evaporation). Jean Rey. Discusses the phenomena of steam compression, compressing machinery and the use of compressed steam in the evaporation of aqueous solutions, etc. Ills. 7500 w. Mem Soc Ing Civ de France—April, 1909. No. 5711 G.

Stokers.

The Characteristics of Automatic Stokers. T. K. Roberts. Considers the construction and operation of various types. Ills. 5000 w. Ind Engng—June, 1909. Serial. 1st part. No. 5802 C.

The Seyboth Mechanical Stoker (Die Rostbeschickungsvorrichtung Bauart Seyboth). W. Hofmann. Illustrated description. 2200 w. Zeitschr f d Gesamte Turbinenwesen—May 10, 1909. No. 5778 D.

See also Smoke Prevention, under STEAM ENGINEERING.

Superheating.

Superheated Steam. Thomas Sugden. Deals with both the principles and practice of superheating. Ills. 8500 w. Pub Works—Jan-March, 1909. No. 5642 D.

Cast Iron Fittings and Superheated Steam. John Primrose. Disproves the theory that ordinary superheat is destructive to cast-iron fittings. 2500 w. Power—June 8, 1909. No. 5322.

See also Pumping Engines, under HYDRAULIC MACHINERY; and Power Plants, under POWER AND TRANSMISSION.

Thermodynamics.

Thermodynamics in Theory and Practice. Considers the points requiring further investigation and the present value of the theory. 1500 w. Engr, Lond—June 11, 1909. No. 5634 A.

Turbines.

Exhaust Steam Turbines. Editorial discussion of the prevailing tendency to use the low pressure turbine as supplemental to non-condensing plants. 1100 w. Elec Age—May, 1909. No. 5427.

Low-Pressure Steam Turbines. C. H. Smoot. Compares the Rateau-Smoot with the Parsons and Curtis types. Ills. 7000 w. Power—June 22, 1909. No. 5815.

Low Pressure Turbines. F. M. Lege, Jr. Discusses the possibilities of the low-pressure steam turbine when operated by the exhaust steam of an existing reciprocating plant. Abstract of paper before the Southwestern Elect. and Gas Association. 2200 w. Elec Ry Jour—June 5, 1909. No. 5254.

A Review of Steam Turbine Development. Discussion of the progress of different types of turbines, with a consideration of their shortcomings. 3500 w. Engr, Lond—May 28, 1909. No. 5265 A.

Curtis Steam Turbines for Large Power Stations. W. E. Miller. General description and extent of use. Ills. 1300 w. Elec Age—May, 1909. No. 5432.

See also Steam Turbines, under MARINE AND NAVAL ENGINEERING.

Turbine Tests.

Test of a 4000 k.w. A.E.G. Curtis Turbogenerator in the Rummelsburg Station, Berlin (Untersuchung eines 4000 K W-A.E.-G.-Turbogenerators in der Zentrale Rummelsburg der Berliner Elektrizitätswerke, Berlin). Describes the test and gives the results. Ills. 2000 w. Zeitschr f d Gesamte Turbinenwesen—May 19, 1909. No. 5779 D.

Valve Gears.

Grunewald's Apparatus for Reversible Compound Engines. An invention designed to shorten the starting and stopping of reversible compound engines. Ills. 400 w. Ir & Coal Trds Rev—May 28, 1909. No. 5412 A.

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TRANSPORTING AND CONVEYING.

Cableways.

The Wetterhorn Cableway (L'Ascensore del Wetterhorn). Detailed description of the driving machinery. Ills. Serial. 1st part. 1600 w. Monit Tech —May 30, 1909. No. 5744 D.

An Ore-transplanting Railway in the Pyranees. A. Gradenwitz. Describes a loading and terminal wire rope tramway connected by a local railway used to transport iron ore from Mt. Canigou to Amelie-les-Bains. Ills. 950 w. Eng & Min Jour—June 5, 1909. No. 5292.

Coal Handling.

Recent Developments in Conveying Machinery for Coal and Ashes. Wilbur G. Hudson. A discussion of the mechanical features and cost-saving of coal-handling machinery. Ills. 2500 w. Engineering Magazine—July, 1909. Serial. 1st part. No. 5977 B.

Coaling Station at Guantanamo, Cuba. W. P. Engelman. Illustrated description of this modern high speed coaling station and its equipment. 1100 w. Ir Age—June 24, 1909. No. 5857.

Hydraulic Coal-Handling Equipment at the Garston Docks. Illustrated detailed description. 4000 w. Ir & Coal Trds Rev—May 14, 1909. No. 5140 A.

Conveyors.

Vacuum Ash Conveyor at Armour Glue Works. George B. Hess. Illustrated description of an installation handling 7 tons per hour, at cost of 7 cents per ton. 2500 w. Power—June 15, 1909. No. 5496.

Cranes.

Early Steam Cranes and Hoists. Fully illustrated history of the early development of fixed and locomotive steam cranes. Shows the more important types before 1870. 4000 w. Engr, Lond—May 28, 1909. No. 5267 A.

Derricks.

A Fifty-Ton Movable Stiff-Leg Derrick. Description of steel erection derrick used on heavy plate-girder work of a railway viaduct by N. Y., N. H. & H. R. R., at Providence. Ills. 1400 w. Eng Rec—June 5, 1909. No. 5279.

Grain Handling.

See Grain Elevators, under CIVIL ENGINEERING, CONSTRUCTION.

Ore Handling.

Ore-Hoisting Appliances at the Wharf of the Tyce Copper Co., at Ladysmith, Vancouver Island, B. C. E. Jacobs. Illustrated description of the bunkers and conveyers. 800 w. Mines & Min—June, 1909. No. 5242 C.

MISCELLANY.

Aeronautics.

Aeronauts and the Law of Trespass. Considers points in connection with this subject. 2000 w. Engng—June 11, 1909. No. 5661 A.

Aviation (Etat actuel de l'Aviation). M. Taris. A review of the theory of mechanical flight, its history and present state. Ills. 6500 w. Ann d Ponts et Chaussées—1909-11. No. 5713 E + F.

Some New American Aeroplanes. Brief descriptions of new types. 1000 w. Sci Am—June 5, 1909. No. 5359.

Aeroplanes of Aerial Experimental Association. G. H. Curtiss. Gives details of four American built machines, with illustrations. 7500 w. Am Mach—Vol. 32. No. 24. No. 5568.

The Davidson "Gyropter" Flying Machine. Description of a flying machine with gyroscopic rotary lifters with radial aeroplanes. Ills. 1800 w. Sci Am Sup —June 5, 1909. No. 5311.

Recent French Aeroplanes and Their Performance. Illustrates and describes recent types. 800 w. Sci Am—June 26, 1909. No. 5894.

The German Military "Zeppelin I." Ansbert Vorreites. Illustrated detailed description of the remodelled third airship of Count von Zeppelin. 2500 w. Sci Am Sup—June 12, 1909. No. 5416.

The Construction of the Zeppelin Airship. Illustrates and describes the construction of "Zeppelin II." 500 w. Sci Am —June 26, 1909. No. 5895.

The Difficulty of Aerial Attack. Sir A. Bannerman. Considers facts bearing on this subject. 3000 w. Jour Roy U Serv Inst—May, 1909. No. 5598 N.

Defense of Harbors Against Naval Airships. F. G. Stone. Short papers on airship scouting, introductory to a general discussions of the airship in warfare. 11500 w. Jour Roy U Serv Inst—May, 1909. No. 5597 N.

Carbonic Acid.

The Physical Properties of Carbonic Acid and the Conditions of its Economic Storage for Transportation. R. T. Stewart's paper is discussed. 4500 w. Jour Am Soc of Mech Engrs—June, 1909. No. 5844 F.

Engraving Blocks.

Making an Engraving Block. Ethan Viall. Illustrates and describes the methods of manufacture. 2000 w. Mach, N Y—June, 1909. No. 5180 C.

Flour Milling Machinery.

See Reinforced Concrete, under CIVIL ENGINEERING, CONSTRUCTION.

Phonographs.

The Production of Sound by Machinery. S. I. Oeisterreicher. Discussion and description of mechanical devices designed to talk and to reproduce spoken words and musical notes. 3500 w. Am Mach—Vol. 32. No. 23. No. 5351.

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MINING AND METALLURGY.

COAL AND COKE.

Coal Cutting.

A Novel Coal and Stone-Cutting Process. Alfred Gradenwitz. Illustrates and describes a system based on the use of driven cables carrying tempered steel cutting points. 2000 w. Eng & Min Jour—June 19, 1909. No. 5620.

Coke Oven Gas.

Comparison Between the Value of Surplus Gas from Regenerator By-Product Coke Ovens, with Special Reference to the Evence Coppee New By-Product Ovens. Mansfeldt H. Mills. Paper read before the Institution of Mining Engineers. 2500 w. Ir & Coal Trds Rev—May 28, 1909. No. 5408 A.

See also Gas Power Plants, under MECHANICAL ENGINEERING, COMBUSTION MOTORS.

Coke Ovens.

The By-Product Coke Oven in Great Britain; Some Characteristic Features of English Coking Coals and New Recovery Processes. D. Bagley. Abstract of a paper before the Int. Cong. of Ap. Chem. 1600 w. Ir & Coal Trds Rev—June 11, 1909. No. 5667 A.

New Coke Ovens and By-Product Plant at Auckland Park Colliery. Illustrated description. 1800 w. Ir & Coal Trds Rev—June 4, 1909. No. 5537 A.

The Smoky Bee-Hives of Birmingham. Lee M'Crae. Brief description of largest battery of coke ovens in the world. Ills. 700 w. Min Wld—June 5, 1909. No. 5383.

Economics.

Financial Burdens on Collieries. An explanation of the conditions of working collieries in Great Britian. 2200 w. Engr, Lond—May 21, 1909. No. 5198 A.

Electric Power.

Electricity in Coal Mines. Robert Nelson. Read before the Inst. of Min. Engrs. Considers the practical application of electricity to coal mining from the point of view of safety. 11500 w. Col Guard—June 4, 1909. No. 5525 A.

The Mines Eight Hours Act and Its Stimulus to Electrical Underground Haulage. Discusses change of equipment and methods in which mechanical devices will replace labor. 2500 w. Ir. & Coal Trds Rev—May 28, 1909. No. 5409 A.

England.

See Economics, under COAL AND COKE.

Explosions.

Effect of Humidity on Mine Explosions. Discussion of the paper by Carl Scholz. 3000 w. Bul Am Inst of Min Engrs—June, 1904. No. 5851 F.

Explosives.

"Permissible" Explosives in Mines. Abstract of first report on tests of explosives by U. S. Geological Survey, giving list of permissible explosives tested prior to May 15, 1909. 1400 w. Elec-Chem & Met Ind—June 1909. No. 5348 C.

The Equipment of the United States Explosives Testing Station. Clarence Hall. Official report of the preliminary result of tests, describing the apparatus and methods. Ills. 6000 w. Engineering Magazine—July, 1909. No. 5971 B.

Germany.

A Model Coal Mine in Westphalia. William S. Hall. Describes the Zollern II. Colliery, where 15 seams varying in thickness from 1½ to 10 feet are worked. Each bed is worked by retreating and the product is carefully washed. Ills. 3400 w. Eng & Min Jour—June 5, 1909. No. 5299.

Illinois.

The Illinois Coal Field. A. Bement. A report of the coal resources of the state, the characteristics of the deposits, quality, etc. Maps. Discussion. 22500 w. Jour W Soc of Engrs—June, 1909. No. 5877 D.

Mine Dust.

The Method of Dealing with the Danger from Coal Dust in the Westphalian Coal District. Read before the Int. Cong. of Ap. Chem. Reports effect of watering and other causes. 1200 w. Col Guard—June 11, 1909. Serial. 1st part. No. 5656 A.

The Coal Dust Question in Great Britain. Henry Hall. Shows how legislature has reduced the number of explosions. 7500 w. Eng & Min Jour—May 29, 1909. No. 5161.

Mine Gas.

The Constituents and Properties of Mine Gases. A. L. Hodges. Discussion of the chemical constitution and properties of poisonous gases. 3400 w. Min Wld—June 5, 1909. No. 5378.

Mining.

Longwall in Inclined Seams. J. G. MacKenzie. Read before the Nova Scotia Soc. of Engrs. Illustrates and describes the method of working a friable gaseous coal at a depth of over 2,000 feet, at Westville, N. S. 2000 w. Mines & Min—June, 1909. No. 5239 C.

Boring as a Means of Security Against Irruptions of Gas and Water

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(Das Vorbohren als Sicherungsmittel gegen Wasser- und Gasdurchbrüche). Herr Stegemann. Describes the practice of exploratory boring followed in some German mines. Ills. 2800 w. Glückauf —May 1, 1909. No. 5756 D.

New Mexico.

The Coal Mines and Plant of the Stag Canon Fuel Co., Dawson, N. M. Jo. E. Sheridan. The geography, geology, mining methods, coal-washing plant, coke-ovens, power plant, waterworks, etc. Ills. 7000 w. Bul Am Inst of Min Engrs—June, 1909. No. 5850 F.

Peat.

Fuel from Peat. Dr. M. Ekenberg. Read before the I. and S. Inst. Researches and experiments with the object of finding a suitable process for converting peat into fuel without air-drying. Ills. 8500 w. Ir & Coal Trds Rev—May 14, 1909. No. 5133 A.

A New Source of Peat Fuel. Thomas Tomlinson. Discussion of the Ekenberg process and disputing claims advanced in its favor. 2400 w. Elec Rev, Lond—May 28, 1909. No. 5418 A.

Ammonia Sulphate from Peat. Describes the Woltereck Process employed at Carnlough, Ireland, where a mixture of air and water vapor is passed over peat maintained at low heat in special furnaces to evaporate the nitrogenous contents which are then treated to yield ammonium sulphate. Ills. 2000 w. Sci Am Sup.—June 5, 1909. No. 5312.

South Africa.

South African Coals and Their Economics. Arthur J. Andrews. Remarks on the inequality in value, and the causes of waste fuel. Discussion. 4000 w. Jour Chem Met & Min Soc of S Africa—April, 1909. No. 5526 E.

United States.

Fuel in the Intermountain Region. D. Harrington. Read before the Utah Soc. of Engrs. A discussion of the distribution of the coal fields. 3500 w. Mines & Min—June, 1909. No. 5240 C.

Valuation.

Pricing Public Coal Lands. Describes the methods of classifying and valuing U. S. Gov't coal lands. 1600 w. Eng & Min Jour—June 5, 1909. No. 5300.

Washing.

Reclaiming Coal from the Culm Pile. Warren O. Rogers. Illustrated description of the operation of washeries in the anthracite region. 2000 w. Power—June 15, 1909. No. 5495.

West Virginia.

New River Coal Field, W. Va. H. H. Stoek. Map and illustrated description of the methods of mining, transportation and business organization. 3500 w. Mines & Min—June, 1909. No. 5244 C.

COPPER.

Anaylsis.

The Precipitation of Copper Oxalate in Analysis. F. A. Gooch and H. L. Ward. An account of the experimental study of conditions under which small as well as large amounts of copper may be determined by the oxalate method. 2200 w. Am Jour of Sci—June, 1909. No. 5543 D.

Arizona.

Ray Copper District, Arizona. William H. Truesdell. Describes the local geology of this copper-producing district. Ills. 3500 w. Min & Sci Pr—June 5, 1909. No. 5509.

Australia.

Mt. Malcolm Copper Mine. Mt. Margaret Goldfield (W. A.) H. P. Woodward. Reviews the history of this mine and its development. 2500 w. Aust Min Stand —May 12, 1909. No. 5823 B.

Copper Mines in Chillagoe District, Queensland. Gerard W. Williams. Describes some of the isolated copper properties in Northeastern Australia, where small scale smelting operations are carried on. Ills. 1150 w. Eng & Min Jour —June 5, 1909. No. 5295.

Great Britain.

Developments of British Copper Mining. H. L. Terry. Reviews recent development work in various districts. 1500 w. Min Jour—May 22, 1909. No. 5194 A.

Mattes.

Experimental Researches on the Nature of Copper Mattes (Recherches expérimentales sur la Nature des Mattes de Cuivre). A. Baykoff and N. Troutneff. Their composition, structure, etc. were investigated. Ills. 7000 w. Rev de Métal—May, 1909. No. 5722 E + F.

Michigan.

Geology of the Porcupine Mountains, Michigan. Alfred C. Lane. Maps and description of this copper region. 1200 w. Min Wld—June 12, 1909. No. 5482.

Mine Waters.

The Precipitation of Copper from Butte Mine Water. Charles J. Stone. A description of the practice by which 750 tons of copper is recovered monthly. Ills. 1800 w. Eng & Min Jour—May 8, 1909. No. 5082.

Peru.

Mining in Morococha, Province of Yauli, Peru. Alberto Jochamonitz. Describes the geology and metalliferous deposits, showing important values in copper and silver. 2200 w. Min Jour—May 22, 1909. No. 5193 A.

Russia.

Notes on the Zangezour Copper Mines. A. L. Simon. Information concerning the location, geology, mining conditions, etc. 3000 w. Inst of Min & Met, Bul. 56—May 13, 1909. No. 5599 N.

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Smelting.

Combined Roasting and Smelting Processes for Copper Ores and Fines. Describes the Fink process tried at the Boston Consolidated Co. plant at Garfield, Utah, and the Catton process tested at West Seattle, Wash. Ills. 1500 w. Elec-Chem & Met Ind—June, 1909. No. 5347 C.

Pyrite Smelting by Knudsen Method in Norway. E. Knudsen. Gives an outline of the method and experience with its use. Ills. 3000 w. Eng & Min Jour—May 29, 1907. No. 5160.

Utah.

Operations of Utah Copper Co. During 1908. D. C. Jackling. Information from the last annual report concerning work accomplished, production, etc. Maps. 4000 w. Eng & Min Jour—June 12, 1909. No. 5477.

GOLD AND SILVER.

Amalgamation.

Electro-Chemical Plate Amalgamation. Elmer Ellsworth Carey. An explanation of the electrolytic system and its claims. 3300 w. Min Jour—June 12, 1909. No. 5630 A.

Progress in Electrochemical Plate Amalgamation. Elmer E. Carey. General discussion of a simple method of converting the standard plate into an electrochemical amalgamating device of remarkable efficiency. 3500 w. Min Wld—June 5, 1909. No. 5379.

The Pierce Amalgamator. Justin H. Haynes. Gives results obtained with it at the Smuggler-Union Mills, Telluride, Colo. 2000 w. Mines & Min—June, 1909. No. 5247 C.

Pan-Amalgamation: An Instructive Laboratory Experiment. H. O. Hofman and C. R. Hayward. Deals with class research work, with special reference to ore treatment. Ills. 3500 w. Bul Am Inst of Min Engrs—June, 1909. No. 5849 F.

Argentina.

The Ore Deposits of the Sierra de Cordoba, Argentine Republic. Dr. G. Bodenbender. Abstract translation. Describes the geology and auriferous deposits. 2500 w. Min Jour—May 29, 1909. Serial. 1st part. No. 5510 A.

Assaying.

Cupellation Experiments; the Thermal Properties of Cupels. C. O. Bannister and W. N. Stanley. A comparison of the behavior of cupels made of other materials than bone-ash, giving an account of experimental work. 4000 w. Inst of Min & Met, Bul. 56—May 13, 1909. No. 5601 N.

Australia.

Charters Towers, Goldfield. W. E. Cameron. An illustrated review, describing the geological features, the main reefs and workings, and giving conclusions in regard to future development. 8000 w. Queens Gov Min Jour—May 15, 1909. No. 5819 B.

Southern End of the Bendigo Goldfield. Donald Clark, M. M. E. Describes important mines in this field. Ills. 2500 w. Aust Min Stand—April 28, 1909. No. 5394 B.

See also Dredging, under GOLD AND SILVER.

California.

See Hydraulic Mining, under GOLD AND SILVER.

Cobalt.

Cobalt's Record to Date. Alex. Gray. A review of the official report of Arthur A. Cole. 2500 w. Min Jour—May 22, 1909. No. 5191 A.

Cobalt in 1908. A. A. Cole. Abstract of report of mining engineer for Cobalt District which now supplies over 9 per cent of the world's production of silver. Discusses production and progress of mining the various ores in district. Ills. 4000 w. Can Min Jour—June 1, 1909. No. 5447.

Colombia.

See Platinum, under MINOR MINERALS.

Dredging.

Dredging at Oroville. Douglas Waterman. Illustrated description of the types of dredges in use, and details of their operation. 3000 w. Min & Sci Pr—June 5, 1909. No. 5506.

Dredging and Hydraulic Sluicing, Victoria, 1908. E. H. Goodenough. Abstract of annual report on operations in 1908. 1500 w. Aust Min Stand—May 5, 1909. No. 5393 B.

Hydraulic Mining.

Hydraulic Mining in California. Al. H. Martin. Describes the La Grange mine, as an example of the methods of gold recovery and the extent and resources of the average California hydraulic property. Ills. 2000 w. Min Wld—June 19, 1909. No. 5673.

Madagascar.

Gold in Madagascar (L'Or à Madagascar). Ch. Marquet. A review of the economic condition of Madagascar and of its gold resources. 6500 w. Mem Soc Ing Civ de France—April, 1909. No. 5709 G.

Mexico.

The Zacatecas District and Its Relation to Guanajuato and Other Camps. C. W. Botsford. Notes on the geology of this district and its relation to other parts of Mexico. 1000 w. Eng & Min Jour—June 19, 1909. No. 5617.

Arteaga District, Chihuahua, Mexico. W. B. Winston. Illustrated account of this highly mineralized district, which

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has proved an abundant producer of gold and silver. 1500 w. Min & Sci Pr—June 12, 1909. No. 5591.

History of the Native-Silver Mines of Batopilas. Walter M. Brodie. Illustrated description of this district in Mexico, the occurrence and mining of the ores. 5000 w. Min Wld—June 12, 1909. Serial. 1st part. No. 5481.

El Tigre Mine, District of Montezuma, Sonora, Mexico. R. L. Herrick. Gives the history of this gold mine and illustrated description of the property. 6000 w. Mines & Min—June, 1909. No. 5237 C.

Nevada.

Goldfield and the Goldfield District of Nevada. John Tyssowski. An account of this camp which has yielded since its discovery, about 50 per cent. of the state's output of gold. Map. 1000 w. Eng & Min Jour—June 19, 1909. No. 5618.

Mining at Hamilton, Nevada. W. S. Larsh. Describes the geology of the White Pine mining district, the silver, lead, and copper belts, and the railroad prospects. 3800 w. Mines & Min—June, 1909. No. 5246 C.

Rejuvenation of the Austin District, Nevada. W. A. Root. Outline of history of Reese River district and proposed plans for extensive working. Ills. 1100 w. Min Wld—June 5, 1909. No. 5380.

Mining Operations in Eldorado District, Nevada. A. G. Hillen. An illustrated article giving a summary of present operations in this district. 3500 w. Min Wld—May 29, 1909. No. 5171.

Panning Standards.

The Use of Standards in Reading Gold Pannings. Stephen J. Lett. Describes standards made and used by the writer. 2200 w. Inst of Min & Met, Bul 56—May 13, 1909. No. 5603 N.

Peru.

See same title, under COPPER.

Placers.

Nature of Gold in Alluvials. F. Lynwood Garrison. Gives facts observed in connection with the study of alluvial gold deposits, and discusses influences that have affected the gold accretion. 3000 w. Min & Sci Pr—May 29, 1909. No. 5207.

IRON AND STEEL.

Analysis.

Note on the Determination of Carbon and Phosphorus in Steel. Andrew A. Blair. Read before the I. and S. Inst. Supplementary to a report presented in 1904. Shows the accuracy of methods used when proper care is taken. 2000 w. Ir & Coal Trds Rev—May 14, 1909. No. 5138 A.

See also Hardness, under MECHANICAL ENGINEERING, MEASUREMENT.

Australia.

Australian Iron and Steel Production. John Plummer. Discussion of the use of iron and steel scrap in connection with the bounty on the making of Australian iron and steel. 750 w. Min Wld—June 5, 1909. No. 5377.

Bessemer Process.

See Converters, under MECHANICAL ENGINEERING, MACHINE WORKS AND FOUNDRIES.

Blast Furnace Practice.

The Principles of Dynamic Chemistry, in Their Relation to the Blast Furnace. W. J. Foster. Abstract of a paper before the Int. Cong. of Ap. Chem. A study of the chemical changes. 1000 w. Ir & Coal Trds Rev—June 11, 1909. No. 5666 A.

Blowing Engines.

See Turbo-Compressors, under MECHANICAL ENGINEERING, POWER AND TRANSMISSION.

Electro-Metallurgy.

Niagara Falls Meeting of the American Electro-chemical Society. Extension and illustrated summary of the meeting with abstracts of papers on Electrometallurgy of iron and steel, and other electro-chemical subjects. Ills. 35,500 w. Elec-Chem & Met Ind—June, 1909. No. 5346 C.

A Study of Electric Furnaces. Charles Albert Keller. From a paper at meeting of the Am. Elec-Chem. Soc. An illustrated account of their application to the manufacture of iron and steel. 6500 w. Ir Age—June 3, 1909. No. 5221.

The Production of Electric Steel. Jas. A. Seager. Illustrated description of the Girod electric furnace, and the properties of steel produced electrically. 1500 w. Ir Trd Rev—June 3, 1909. No. 5228.

The Electric Furnace and Electrical Process of Steelmaking. W. Rodenhauser. Read before the I. and S. Inst. An illustrated summary of types of furnaces in present use, with particular reference to the Rochling-Rodenhauser furnace. 7500 w. Ir & Coal Trds Rev—May 14, 1909. No. 5134 A.

See also Castings, under MECHANICAL ENGINEERING, MACHINE WORKS AND FOUNDRIES.

Germany.

The Lorraine Deposits of Oolitic Iron Ore. Tony Callot. Describes these extensive deposits. 4000 w. Eng & Min Jour—June 19, 1909. No. 5616.

Ingots.

The Riemer Hot Top Process of Prevention Piping in Steel Ingots. J. F. Springer. An explanation of piping and illustrated descriptions of processes to prevent it, especially the process named. 6000 w. Ir Trd Rev—June 24, 1909. No. 5883.

The Harmet Process of Ingot Compression. J. F. Springer. Illustrated de-

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scription of the apparatus, process, and results. 2500 w. Ir Age—June 24, 1909. No. 5859.

Lake Superior

Mesabi Range Mining. J. Fred Wolff. Describes the three prominent methods of mining, the open-pit, milling, and underground systems. Ills. 4800 w. Wis Engr—June, 1909. No. 5690 D.

Open Hearth.

Automatic Control of Motors Operating Open Hearth Tilting Furnaces. Illustrated description of the arrangements at the works of the Jones & Laughlin Steel Co., Pittsburgh, Pa. 2000 w. Elec Jour—June, 1909. No. 5550.

Piping.

See Ingots, under IRON AND STEEL.

Rolling Mills.

Function of Fly-Wheels in Connection with Electrically Operated Rolling Mills. H. C. Specht. Reviews the characteristics of the load curve of a fly-wheel in connection with an induction motor. 2000 w. Pro Am Inst of Elec Engrs—June, 1909. No. 5835 F.

Determining the Amount of Power Required in Rolling Mills. Extracts from an article in *Stahl und Eisen*, by Dr. H. Ortmann, reviewing extensive experiments made by direction of the German Ironmaster's Assn. Ills. 7000 w. Ir & Coal Trds Rev—May 14, 1909. No. 5139 A.

The Power Requirements of Rolling Mills (Der Kraftbedarf von Walwerken). H. Groeck. Results of electric-driving tests. Ills. 4000 w. Zeitschr d Ver Deutscher Ing—May 22, 1909. No. 5967 D.

New Methods for the Design of Roll Grooves (Neue Methoden zur Berechnung von Kalibrierungen). W. Tafel. Describes methods of designing rolls for rolling various profiles. Ills. 7700 w. Stahl u Eisen—May 5, 1909. No. 5747 D.

The New Rolling Mill Plant of the Westfalian Steel Company in Bochum (Die neuen Walzwerksanlagen der Westfälischen Stahlwerke in Bochum). Illustrated detailed description. 2000 w. Stahl u Eisen—May 26, 1909. No. 5750 D.

Steel Making.

Old Material in Steel Production. Editorial discussion of the position of iron and steel scrap. 2500 w. Ir Age—June 10, 1909. No. 5508.

Sweden.

Making Iron in Sweden. A. F. Backlin. Illustrates and describes early and modern practice. 1500 w. Ir Trd Rev—June 3, 1909. No. 5229.

LEAD AND ZINC.

Missouri.

Typical Mining Practice in Southeast Missouri. Otto Ruhl. Illustrates and describes the system. 2500 w. Min Wld—May 29, 1909. No. 5169.

MINOR MINERALS.

Alunite.

Determination of Alunite. R. B. Gage. Describes laboratory and field methods for its quantitative and qualitative determination. 2400 w. Eng & Min Jour—June 5, 1909. No. 5294.

Prospecting for Ores of the Goldfield Type. J. Volney Lewis. Discusses conditions under which Alunite indicates the presence of gold and its occurrence. 1150 w. Eng & Min Jour—June 5, 1909. No. 5293.

Arsenic.

Arsenic (As). E. B. Wilson. Deals with its uses, occurrence, tests, methods of analysis, etc. 3000 w. Mines & Min—June, 1909. No. 5243 C.

Asbestos.

Mineral Deposits of the Serpentine Belt of Southern Quebec. John A. Dresser. Read before the Canadian Mining Institute. Discusses geology and occurence and production of asbestos. Ills. 3700 w. Can Min Jour—June 1, 1909. No. 5448.

Borate.

The Borate Deposits of the Atacama Desert, Argentine Republic. Dr. Fritz Reichert. Briefly describes the most important deposits, giving geological data. 2500 w. Min Jour—June 12, 1909. No. 5632 A.

Gypsum.

Gypsum Mining. W. J. Jones. Describes the application of room and pillar methods at mines near Akron, N. Y. 1000 w. Mines & Min—June, 1909. No. 5238 C.

Monazite.

Monazite and Monazite-Mining in the Carolinas. Joseph Hyde Pratt, and Douglas B. Sterrett. Describes the mineral, its occurrence, geology, the deposits, magnetic separation, and uses. Ills. 9500 w. Bul Am Inst of Min Ingrs—June, 1909. No. 5848 F.

Natural Gas.

Geology as Applied to the Formations in which Natural Gas is Found in the Appalachian Regions. John Adams Bownocker. Considers only the northern part of this field. 6000 w. Am Gas Lgt Jour—June 28, 1909. No. 5929.

The Bottineau Gas Field. John G. Barry. Describes this region in North Dakota. 800 w. Eng & Min Jour—May 29, 1909. No. 5162.

See also Oil, under MINOR MINERALS.

Nitrates.

The Nitrates of Tarapaca, Chile. V. Quezada Carneyro. Describes the nature and genesis of these deposits. 2200 w. Min Jour—May 22, 1909. No. 5192 A.

Oil.

The Genesis of Petroleum Deposits (Die Entstehung der Erdöllagerstätten). Hans Höfer. A review of theories. 3600 w.

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Oest Zeitschr f Berg u Hüttenwesen—May 22, 1909. No. 5754 D.

Oil and Gas in the St. Louis District. H. A. Wheeler. Shows the value of geologic aid in prospecting for oil and gas, describing the Illinois fields. Diagrams. 4500 w. Jour Assn of Engng Socs—April, 1909. No. 5840 C.

Pegmatites.

The Gem Bearing Pegmatites of Western Maine. W. Rogers Wade. History and description of the deposits where tourmaline, beryl, feldspar and mica are obtained. 4000 w. Eng & Min Jour—June 5, 1909. No. 5296.

Platinum.

Geology of the Platinum Deposits of Colombia. J. Ciceron Castillo. Describes the conditions and the gold and platinum deposits of this region. Map. 1700 w. Min & Sci Pr—June 12, 1909. No. 5590.

Precious Stones.

Mining for Gems in Brazil. A. S. Atkinson. Explains the general conditions and the results. 2200 w. Eng & Min Jour—June 19, 1909. No. 5619.

Salt.

Salt Production with exhaust steam. Norman B. Beasley. Describes the evaporation of brine as practiced in Michigan. 800 w. Eng & Min Jour—June 5, 1909. No. 5303.

Tin.

Tin—Its History, Uses and Occurrence. Arthur Lakes. Information relating to the geology and mineralogy; the history, sources, uses, &c. Ills. 2500 w. Min Wld—June 19, 1909. No. 5674.

The Bessermerizing of Hardhead. Donald M. Levy and D. Ewen. Gives the scope of research work with this waste product of tin smelting, and a summary of the experiments. 2500 w. Inst of Min & Met, Bul. 56—May 13, 1909. No. 5602 N.

Tin Deposits of the Carolinas. S. Mays Ball. Describes the tin deposits and the extent to which they have been worked. 1200 w. Eng & Min Jour—June 5, 1909. No. 5301.

Tin Mining and Milling in North Queensland. G. W. Williams. Notes on these tinfields, and the need of modern methods to develop the lowgrade ores. 2500 w. Eng & Min Jour—May 29, 1909. No. 5163.

King of the Ranges Tin Mine, Watsonville, N. Q. Lionel C. Ball. Information in regard to the workings and the geology 4000 w. Queens Gov Min Jour—May 15, 1909. No. 5820 B.

Tungsten.

The Determination of Tungstic Acid in Low-Grade Wolfram Ores. H. W. Hutchin. Describes a new method, claiming advantages in time, accuracy, and general utility. 4000 w. Inst of Min & Met, Bul 56—May 13, 1909. No. 5600 N.

The Determination of Tungstic-Acid in Low Grade Ores. Abstract of a paper describing the aqua regia method, aqua regia with previous treatment with hydrofluoric acid, and fusion with alkalis and subsequent determination with mercurous nitrate. 1500 w. Eng & Min Jour—June 5, 1909. No. 5302.

Uranium.

Uranium Ores (Die Uranerze). A brief review of the uranium minerals. 2000 w. Oest Zeitschr f Berg u Hüttenwesen—May 15, 1909. No. 5753 D.

MINING.

Boring.

Churn Drills in Ely District. J. L. Dobbins. Illustrates and describes the prospecting with these drills on the ground of the Nevada Consolidated Copper Co. 2200 w. Mines & Min—June, 1909. No. 5248 C.

Drills.

Selection and Use of Bits for Power Drills. M. de Gennes. Discusses the different types and the effect of size, shape, and cutting edge on the results. 1500 w. Eng & Min Jour—June 12, 1909. No. 5476.

Drill Sharpening.

Calumet and Hecla Drill-Sharpening Device. C. L. C. Fichtel. Illustrated description of a plant that handles about 4000 drills a day. 1200 w. Eng & Min Jour—May 29, 1909. No. 5157.

Earth Pressures.

The Causes of Extraordinarily High Earth Pressures in the Zwickau District and their Effects on the Shafts and Galleries (Die Ursachen des aussergewöhnlich hohen Gebirgsdruckes in einem Teile des Zwickauer Reviers and seine Wirkung auf die Schachte und Füllorter). Dr. Niess. Ills. 5000 w. Glückauf—May 29, 1909. No. 5760 D.

Electric Hoisting.

Operation of Mine Hoists by Electric Motors. C. V. Allen. Illustrated description, with special reference to the installation of the El Oro Mining and Railway Co., Ltd., 2000 w. Elec Jour—June, 1909. No. 5546.

Explosives.

Standardization of Blasting Explosives. M. B. Lloyd. Read before the Int. Cong. of Ap. Chem. Presents the desirability of standardization, and outlines a system. 700 w. Col Guard—June 11, 1909. No. 5655 A.

Gas Power.

Suction Gas and Its Application to Mining. George D. Stephen. Describes an installation in Cumberland, England. 2000 w. Eng & Min Jour—May 29, 1909. No. 5158..

Haulage.

See Electric Power, under COAL AND COKE.

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Law.

Australian Mineral Leasing. A. C. Veatch. Summarizes recent mining enactments, all of which are based on the policy of mineral leasehold. An address delivered before the Conservation Commission, Dec. 3, 1908. 2400 w. Eng & Min Jour—June 5, 1909. No. 5298.

Leasing System.

See Law, under MINING.

Mine Cars.

An Improved Type of Mine Car Wheel. J. E. Johnson, Jr. Descriptive. 1500 w. Eng & Min Jour—June 12, 1909. No. 5475.

Ore Handling.

See same title, under MECHANICAL ENGINEERING, TRANSPORTATION AND CONVEYING.

The Panel System as Applied to Metal Mining. H. E. West. Explains the physical characteristics of the deposit which made this method desirable. Ills. 2000 w. Eng & Min Jour—June 12, 1909. No. 5474.

Prospecting.

See Boring, under MINING.

Quarrying.

See Coal Cutting, under COAL AND COKE.

Records.

Recording Engineering Records. Lee Hayes. Describes methods used by the Boston and Montana Consolidated Copper and Silver Mining Co., Butte, Montana. 4500 w. Mines & Min—June, 1909. No. 5241 C.

Shaft Sinking.

Sinking the Concrete-Lined No. VI Shaft at the Rhein-Elbe Mine (Das Abteufen des Schachtes Rhein-Elbe VI mit Eisenbetonausbau in Steinkohlengebirge). Herr Kaufmann. Illustrated description of the work. 4000 w. Glückauf—May 1, 1909.. No. 5757 D.

Timbering.

The Use of Concrete for Mine Supports. W. R. Crane. Paper read before the Institution of mining engineers. Descusses its profitable use in mining, costs, methods, etc. Ills. 6000 w. Ir & Coal Trds Rev—May 28, 1909. No. 5454 A.

Transportation.

Mule-Back Transportation of Sectionalized Machinery. F. C. Roberts and Walter W. Bradley. Illustrated description of methods used in transporting machinery to districts accessible only by mule-back. 4000 w. Min & Sci Pr—May 29, 1909. No. 5206.

Freighting Ore with Big String Teams. George C. McFarlane. An account of practice in California and its cost. 1500 w. Eng & Min Jour—May 29, 1909. No. 5159.

Tributing.

Tributing. H. F. Lofts. A discussion of this system of mining. 2500 w. Min Jour—June 5, 1909. No. 5524 A.

Wire Rope.

The Testing of Wire Rope (Prüfung der Drahtseile). Hermann Kroen. A mathematical discussion of its strength with tables of data. Ills. 3200 w. Oest Zeitschr f Berg u Hüttenwesen—May 29, 1909. No. 5755 D.

See also same title, under MECHANICAL ENGINEERING, MATERIALS OF CONSTRUCTION.

ORE DRESSING AND CONCENTRATION.

Copper.

The Ohio Concentrator. Leroy A. Palmer. A description of the mill at Bingham, Utah, which will have a capacity of 2250 tons per day. 2500 w. Mines & Min—June, 1909. No. 5245 C.

Gold Milling.

Salt Water in Stamp-Mills. T. A. Rickard. Describes the effect of salt water, and the method of clearing the tables in the Alaska-Treadwell mill. Ills. 1500 w. Min & Sci Pr—June 19, 1909. No. 5827.

See also Amalgamation, under GOLD AND SILVER; and Foundations, under CIVIL ENGINEERING, CONSTRUCTION.

Lead Milling.

Milling Practice in South-east Missouri District. Otto Ruhl. Illustrated description of the practice in the disseminated lead district, and its development. 2500 w. Min Wld—June 19, 1909. No. 5671.

Magnetic Separation.

See Monazite, under MINOR MINERALS.

Roasting.

Some Developments of Blast Roasting. H. O. Hofman. Describes the up-draft and downdraft roasting apparatus used for these processes. 2200 w. Min Jour—June 12, 1909. No. 5631 A.

Slimes Treatment.

Theory of the Settlement of Slime. Harrison Everett Ashley. Supplementary to a paper by H. S. Nichols, published July 11, 1908, in this same paper. 1000 w. Min & Sci Pr—June 12, 1909. No. 5592.

Method for Saving Slimes in Ore Concentration. James N. Flood. Illustrates and describes a method and apparatus for saving slimes and float metal in concentrating processes where a flow of dressing water is employed. 2000 w. Min Wld—May 29, 1909. No. 5170.

Stamp Mills.

The Mechanics of Stamp Mills (zur Mechanik der Pochwerke). M. Herrmann. Mathematical discussion. Ills. Serial, 1st part. 2000 w. Oest Zeitschr f Berg u Hüttenwesen—May 1, 1909. No. 5752 D.

Tube Mills.

Tube-Mill Liners. F. C. Brown. De-

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scribes the "ribbed liner" which has given satisfaction at the Komata Reefs and Waihi Grand Junction mines, Diagrams. 1500 w. N Z Mines Rec—April 16, 1909. No. 5822 B.

MISCELLANY.

Alloys.

Metallographic Researches at the Göttingen Institute of Mineral Chemistry (Recherches métallographiques effectuées à l'Institut de Chimie minérale de Göttingen). G. Tammann. A brief review of the results of researches on the constitution of alloys. Ills. 4500 w. Rev Gen des Sciences—May 15, 1909. No. 5728 D.

The Preparation and Properties of Silico—Manganese and Commercial Silico-Spiegel (Préparation et Propriétés des Silico-manganèses et Silico-Spiegels industriels). Jean Escard. Describes the preparation of these alloys in the electric furnace. 3200 w. L'Elecn—May 8, 1909. No. 5729 D.

Applied Chemistry.

The International Congress of Applied Chemistry. A report of the 7th Congress recently held in London, with abstracts of papers. 7000 w. Engng—June 4, 1909. Serial. 1st part. No. 5529 A.

Atomic Theory.

Suggestions for a New Atomic Theory. James Moir. An explanation of the writer's theory which is based upon the carbon atom. Diagrams and discussion. 5500 w. Jour Chem, Met & Min Soc of S Africa—April, 1909. No. 5527 E.

Australia.

The Mining Industry of Queensland. General review of industry for 1908 from report of Under-Secretary for Mines. Ills. 2900 w. Aust Min Stand—April 28, 1909. No. 5395 B.

California.

Historical Geology of California. William Forstner. Aims to collect and epitomize the literature on this subject. Ills. 3500 w. Min & Sci Pr—June 19, 1909. Serial. 1st part. No. 5826.

Greece.

Mining Industry of Greece. George Horton, U. S. Consul. Brief discussion of conditions of the industry. 1100 w. Min Wld—June 5, 1909. No. 5381.

Ore Deposits.

Features of a Vein Formation in Nicaragua. H. E. West. Describes the vein-system and orebodies which apparently are the results of the fracture and decomposition of effusive rocks. Ills. 3000 w. Eng & Min Jour—June 5, 1909. No. 5297.

Turkey.

Mineral Resources of the Turkish Empire. Leon Dominian. Describing the mineral deposits known, and their location. Map. 4500 w. Min & Sci Pr—June 12, 1909. No. 5589.

RAILWAY ENGINEERING.

CONDUCTING TRANSPORTATION.

Accidents.

Decrease in Railway Fatalities in 1908. Editorial discussing railway accidents in Great Britain and the United States. 1000 w. Engng—May 28, 1909. No. 5261 A.

Signaling.

The A B C of Railroad Signaling. W. H. Elliott. An explanatory outline of practice in the United States. 4000 w. Sig Engr—June, 1909. Serial. 1st part. No. 5675.

The Semaphore; Upper Left vs. Upper Right. From a paper by C. H. Morrison, discussing the merits of different arrangements. Ills. 1400 w. R R Age Gaz—June 11, 1909. No. 5472.

Concerning the Handling of Wire. Stanley C. Bryant. Illustrated suggestions for the handling of copper wire and the manner of making joints and tops in signal work. 1800 w. Sig Engr—June, 1909. No. 5676.

Track Circuits and Batteries. George S. Hodgins. Explains the arrangement and operation of automatic signals. 2000 w. Ry & Loc Engng—June, 1909. No. 5234 C.

Federal Electric Interlocking at Indianapolis. Brief description of two all-electric interlocking plants recently installed. 1200 w. R R Age Gaz—June 25, 1909. No. 5886.

All-Electric Interlocking at Allentown. Illustrated description of this plant. 700 w. R R Age Gaz—June 18, 1909. No. 5613.

Interlocking in Europe. Abstract of report by Adams and Ames, Interstate commerce commission. Outlines systems employed. Ills. 1800 w. R R Age Gaz—June 4, 1909. No. 5288.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Percentage of Power Brakes on Trains. Discusses the proposed increase in the percentage of cars equipped with air brakes. 900 w. Am Engr & R. R. Jour—June, 1909. No. 5342 C.

Car Painting.

Painting Steel Cars. George L. Fowler.

We supply copies of these articles. See page 887.

Calls attention to points in the usual practice that help to account for the frequent poor results. 3500 w. R R Age Gaz—June 18, 1909. No. 5612.

Couplers.

A New Automatic Coupler (Eine neue selbsttätige Mittelpufferkuppelung). K. Scharfenberg. Illlustrated description of a new type used on a narrow-gauge road in Germany. 1800 w. Glasers Ann—May 1, 1909. No. 5783 D.

Electrification.

Railway Electrification. N. W. Storer. Abstract of a lecture on reasons why railways should be electrified. 1200 w. Sib Jour of Engng—June, 1909. No. 5809 C.

Some Phases of Steam-Railroad Electrification in the United States. Edward N. Lake. A study of progress and discussion of the outlook. 4000 w. Engineering Magazine—July, 1909. No. 5970 B.

Freight Cars.

General Service Steel Gondola Cars. Description of new steel cars with doors to permit of gravity dumping. Over 99 per cent. of the loading can be discharged by gravity in the latest type of cars. Ills. 600 w. Am Engr & R R Jour—June, 1909. No. 5339 C.

Steel Car for Carrying Plate Glass. Description and drawings of a new car for the Pittsburg Plate Glass Co. Ills. 500 w. Am Engr & R R Jour—June, 1909. No. 5331 C.

Locomotive Ash Pans.

Self Clearing Ash Pans. Discusses the leading types of ash pans which fulfil the requirements of the ash-pan law in effect on Jan. 1, 1910, for railways engaged in interstate or foreign traffic. Ills. 2600 w. Am Engr & R. R. Jour—June, 1909. No. 5337 C.

Locomotive Ash Pan Attachment. Describes an improved ash pan invented by T. W. Anderson, where warping does not interfere with the dumping mechanism. Ills. 1100 w. Ry & Engng Rev—June 5, 1909. No. 5373.

Locomotive Boilers.

Government Supervision and Inspection of Locomotive Boilers. A critical discussion of bill No. 236, introduced in the United States Senate on March 22, with editorial. 5000 w. R R Age Gaz—June 11, 1909. No. 5469.

Comparative Tests of Water Tube and Standard Fireboxes. S. S. Riegel. Describes tests of 1-in. scale models in which a large gain in the amount of water evaporated by the water tube boiler designed by the author was shown. Ills. 1400 w. Am Engr & R R Jour—June, 1909. No. 5340 C.

Economy in Boiler Washing. Illustrates and describes the National Boiler Washing System in use on the A. T. & S. F. Ry., explaining its value. 1500 w. Ry & Engng Rev—June 19, 1909. No. 5670.

Locomotive Construction.

Comparison of Locomotive Building in the United States, Germany and France. Marcel Bloch. Trans. from *Rev. Gen. des Chem. de Fer.* Investigates the causes that justify the difference in price and delivery. 2500 w. R R Age Gaz—June 11, 1909. Serial. 1st part. No. 5470

Locomotive Economy.

Steam Consumption of Locomotives (Dampfverbrauch der Lokomotiven). Herr Obergethmann. Discusses the various factors affecting it, gives results of tests, etc. 8300 w. Glasers Ann—May 15, 1909. No. 5785 D.

Locomotive Fireboxes.

A Locomotive Firebox Without Staybolts in the Side Sheets and Crown Sheet. Illustrated description of the Jacobs-Shupert system, Atchison, Topeka & Santa Fe Ry. Also editorial. 3500 w. Eng News—June 17, 1909. No. 5579.

Locomotive Fuels.

Briquetting Tests at the United States Fuel-Testing Plant, Norfolk, Virginia, 1907-8. Charles L. Wright. Illustrated description of the U. S. Geol. Survey plant at Norfolk, and its equipment, with report of tests. 8000 w. U S Geol Survey—Bul. 385. No. 5856 N.

Locomotive Maintenance.

Efficient Foremen. J. F. Whiteford. Discusses the training and supervision of road foremen of engines to secure the greatest efficiency. Ills. 4200 w. Am Engr & R. R. Jour—June, 1909. No. 5335 C.

Locomotives.

Some Remarkable Locomotives of 1908. J. F. Gairns. An illustrated review of locomotive development during the year. 4500 w. Cassier's Magazine—June, 1909. No. 5539 B

Articulated Compound Locomotives. Discussion of C. J. Mellin's paper. 6500 w. Jour Am Soc of Mech Engrs—June, 1909 No. 5846 F.

Details of Articulated Mallet Compound Locomotive. Describes in detail features of valves, reversing gear, and oil heater. Ills. 1400 w. R. R. Age Gaz—June 4, 1909. No. 5289.

Mallet Articulated Compound Locomotive for the Virginian Railway. Plate, and illustrated description of engines for handling traffic on steep grades. 2000 w. R R Age Gaz—June 18, 1909. No. 5614.

New Locomotives for the St. Louis Southwestern Ry. Illustrates and describes types. 800 w. Ry & Engng Rev—June 19, 1909. No. 5669.

Consolidation and Pacific Type Locomotives for the Chicago and Alton Railroad. Description of 16 heavy freight locomotives supplied with Baker Pilliod valve

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gear and of 5 large Pacific locomotives similarly equipped. Ills. 3400 w. Ry & Engng Rev—June 5, 1909. No. 5367.

Consolidation Locomotive with New Design of Fire Tube Superheater. Describes one of a series of ten engines built for the Wabash Pittsburgh Terminal Railway. This locomotive carries 160 lbs. steam pressure and has 25-in. cylinders as against 200 lbs. and 22-in. cylinders for the other nine. Ills. 1000 w. Am Engr & R. R. Jour—No. 5341 C.

Heavy Consolidation for Wabash-Pittsburgh Terminal. Illustrated description of a recently built heavy 2-8-0 freight engine. 800 w. Ry & Loc Engng—June, 1909. No. 5233 C.

Mikado Type Freight Locomotive. Description of powerful freight locomotive of the 2-8-2 type for the Virginian Rway. Ills. 1800 w. Am Engr & R. R. Jour—June, 1909. No. 5330 C.

Mikado Type Locomotives Built by C. M. & St. P. Ry. Illustrated detailed description. 1000 w. Ry & Engng Rev—May 29, 1909. No. 5168.

Compound Passenger Locomotive. Illustration and particulars of an engine for the Central Argentine Railway. 500 w. Engr, Lond—June 11, 1909. No. 5636 A.

Twelve-wheeled Duplex Tank Locomotive; Nitrate Railways Company, Chili. Plate and illustrated details. 500 w. Engng—May 21, 1909. No. 5195 A.

Two New French Locomotives. Illustrations and particulars of the 6-coupled express engine for Chemin de Fer du Nord, and the P. L. M. suburban and Riviera tank engine. 300 w. Engr, Lond—June 4, 1909. No. 5535 A.

The New Four-Cylinder Compound Locomotive with Three Coupled Axles, Series A 3-5, of the Gotthard Railway (Die neue Vierzylinder - Verbund - Lokomotive mit drei gekuppelten Achsen, Serie A 3-5, der Gotthardbahn). Illustrated description. Plate. 2000 w. Schweiz Bau—May 1, 1909. No. 5765 B.

Locomotive Superheaters.

Low, Moderately and Highly Superheated Steam. F. J. Cole. Discusses the advantages and economy of superheated steam in railway locomotives. 3200 w. Am Engr & R R Jour—June, 1909. No. 5329 C.

Locomotive Symbols.

Uniformity in the Symbols Used to Represent Different Types of Locomotives. P. Labryn. Gives explanation of systems used. 1000 w. Bul Int Ry Cong—May, 1909. No. 5685 G.

Locomotive Tenders.

Location of Side Bearings on Tender Trucks. Theodore H. Curtis. Discusses the proper design of locomotive tenders. Ills. 1150 w. Am Engr & R. R. Jour—June, 1909. No. 5334 C.

Locomotive Testing.

Combustion and Evaporation. Lawford H. Fry. Discussion of an analysis of the testing of locomotives at the St. Louis Exposition by Joseph Nodal in his book *Locomotives à Vapour*. 1650 w. Am Engr & R. R. Jour—June, 1909. No. 5332 C.

Locomotive Valve Gears.

The Walschaerts Valve Gear as Applied to Locomotives. The present number deals with the general principles. 1200 w. Ry & Loc Engng—June, 1909. Serial. 1st part. No. 5235 C.

Locomotive Wheels.

Flange Wear of Driving Tires. R. H. Rogers. Discusses the possible elimination of flange wears. Ills. 2000 w. Am Engr & R. R. Jour—June, 1909. No. 5338 C.

Motor Cars.

Motor Section Cars on the C., M. & St. P. Ry. An illustrated account of the use of these cars, describing the details. Also editorial. 3000 w. Ry & Engng Rev—June 19, 1909. No. 5668.

Accumulative Cars for the Prussian State Railways (Akkumulator-Doppelwagen für die preussische Staatsbahn verwaltung). H. Becker. A complete description. Ills. 3000 w. Elek Kraft u Bahnen—May 14, 1909. No. 5952 D.

Motor Car Traffic on the Prussian-Hessian State Railways (Triebwagenverkehr auf den preussisch-hessischen Staatsbahnen). Describes the work of the new accumulator cars. Ills. 2000 w. Elek Kraft u Bahnen—May 14, 1909. No. 5951 D.

Snow Plows.

A Rotary Snow Plow on the Orléans Railway (Chasse-Neige rotatif à Vapeur de la Compagnie d'Orléans). M. Conte. Illustrated description. 3000 w. Rev Gen des Chemins de Fer—May, 1909. No. 5727 C.

Train Resistance.

The Resistance of Railway Trains. Albert Frank. Statements in reply to Prof. Carus-Wilson's criticism of the experimental formulae established by the author. 2000 w. Bul Int Ry Cong—May, 1909. No. 5683 G.

Wheels.

Schoen Steel Wheels. Information concerning standard designs and specifications for various classes of service. Ills. 3000 w. Ir Age—June 17, 1909. No. 5566.

NEW PROJECTS.

Chile.

The Construction of the Transandine Railway. Illustrated description of the connecting link in the first railway to join the Atlantic and Pacific Oceans across South America. 1500 w. Eng Rec—June 5, 1909. No. 5277.

India.

The Pegu-Moulmein Railway and Sittang River. A. Stewart Buckle. An il-

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lustrated accoount of the construction of this recently completed railway in Burma. 3500 w. Engr, Lond—June 4, 1909 Serial. 1st part. No. 5534 A.

PERMANENT WAY AND BUILDINGS.

Crossings.

Grade Crossings, H. J. Pfeifer. Discusses matters in connection with the elimination of grade crossings. General discussion follows. 7000 w. Pro St. Louis Ry Club—May 14, 1909. No. 5545.

Curves.

Easement Curves. Robert H. Smith. Mathematical discussion. 3000 w. Engr, Lond—June 4, 1909. No. 5533 A.

Joining Curves and Tangents (Note sur le Raccordement des Courbes et des Alignements dans les Voies de Chemins de Fer). M. Collot. A mathematical discussion of the method of laying out curves in railway track Ills. 5500 w. Rev Gen des Chemins de Fer—May, 1909. No. 5726 G.

Elevated Railways.

A Review of Track Elevation in Chicago. Shows the progress of the work since its inception. 3000 w. Eng News—June 3, 1909. No. 5219.

Chicago Track Elevation. M. K. Trumbull. Summary of a voluminous report dealing with the rebuilding of railways in Chicago. Map and tables. 3000 w. R. R Age Gaz—June 4, 1909. No. 5291.

Track Elevation in Chicago. Information from a recent work giving the history of the extensive work for the elimination of grade crossings. Map. 4000 w. Eng Rec—May 29, 1909. No. 5143.

Location.

The Location of Railways in Mountainous Countries (Die wirtschaftliche Linienführung bei Gebirgsbahnen). L. Potterat. A discussion of economic considerations. Ills. 3000 w. Schweiz Bau—May 29, 1909. No. 5769 B.

Rack Railways.

The Chamonix and Mer de Glace Railway. William F. Johnston. Illustrated description of a new rack railway in the Mont Blanc region. 1500 w. Eng Rec—June 12, 1909. No. 5485

Rail Creeping.

Rail Creeping and Its Prevention (Die Schienenwanderung und ihre Verhütung). Alfred Wirth. An exhaustive study, describing rail-fastening devices. Ills. Serial, 1st part. 5000 w. Zeitschr d Oest Ing u Arch Ver—May 14, 1909. No. 5788 D.

Rail Testing.

Machine for Testing Railway Rails. Illustrated description of the rail testing machine designed by the Pennsylvania Steel Co. 1200 w. Ry & Loc Engng—June, 1909. No. 5232 C.

Reconstruction.

The Waterbury Improvements of the New Haven Railroad. Illustrates and describes improvements including the change from single to double track, realignment, elimination of grade crossings, etc. 2500 w. Eng Rec—May 29, 1909. No. 5144.

Stations.

The Enlargement of the Vohwinkel Station and its Improvement of Conditions (Die Bahnhofserweiterung in Vohwinkel und ihre Einwirkung auf den Betrieb). Herr Claus. Describes the extensive improvements. Ills. Plate. 4500 w. Glasers Ann—May 15, 1909. No. 5784 D.

Switches.

Practical Railway Track Work—Switches. K. L. Van Auken. A consideration of switch construction work. 4000 w. Wis Engr—April, 1909. No. 5689 D.

Ties.

Railway Ties in France. A U. S. Consular Report from Havre describing use of timber ties on French railways and opportunities for the introduction of American ties. 900 w. Ry & Engng Rev—June 5, 1909. No. 5369.

Track Construction.

Mechanical Appliances for Track-Laying. J. F. Springer. Illustrated description of the recent developments in machines for the continuous construction of permanent way. 5500 w. Cassier's Mag—June, 1909. No. 5542 B.

Track Maintenance.

Modifications of Ordinary Methods in the Execution of Work on the Roadbed of an Operating Railway (Ueber Modifikationen normaler Baumethoden anlässlich der Ausführung diverser Objekte im Unterbau eines betriebenen Bahngeleises). Johann Basta. Discusses various classes of work. Ills. Plates. Serial. 1st part, 5000 w. Oest Wochenschr f d Oeffent Baudienst—May 1, 1909. No. 5790 D.

See also Motor Cars, under Motive Power and Equipmept.

TRAFFIC.

Freight Claims.

Freight Claim Departments. W. L. Schneider. Gives a summary of the present manner of handling unclaimed freight, and suggests improvements. 1800 w. R R Age Gaz—June 25, 1909. No. 5887.

Freight Handling.

Freight-Handling Equipment. Werner Broecklin. Illustrates and describes interesting methods of mechanical handling and suggests possible extensions. 2500 w. Engineering Magazine—July, 1909. No. 5975 B.

MISCELLANY.

Management.

Methods of the Santa Fe. Efficiency in the Manufacture of Transportation. Charles Buxton Going. Fifth and last article of a series, discussing the apprenticeship system and relations with employers. Ills. 5000 w. Engineering Magazine—July, 1909. No. 5973 B.

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STREET AND ELECTRIC RAILWAYS.

Accounting.

The Accounting Department. W. B. Wright. Abstract of paper describing organization and routine of the accounting department, its relation to other departments, and the duties of its chief. Read before Central Elec. Ry. Association. 2500 w. Elec Ry Jour—June 5, 1909. No. 5255.

Adelaidé, Australia.

Adelaide Electric Tramways. Description of a modern plant and system operated by a municipal trust. Ills. 5500 w. Aust Min Stand—April 28, 1909. No. 5458 B.

Car Barns.

Street Railway Car House Design and Operation. H. B. Fleming. Abstract of paper presented at a joint meeting of Western Society of Engineers and Chicago Section American Institute of Electrical Engineers, Chicago, May 28. 1800 w. Elec Ry Jour—June 5, 1909. No. 5258.

Cars.

A Novel Street-Railway Car. P. W. Price. Illustrated description of a prepayment type of car with center exit in use in Pittsburg. 600 w. Eng News—June 17, 1909. No. 5577.

Car Weights.

Car Weights as Affecting Operating Costs. Abstract of a paper by Milan V. Ayres, read at a meeting of Mass. St. Ry. Assn. 2200 w. Elec Ry Jour—June 19, 1909. No. 5593.

Direct Current.

Direct-Current, 1200-Volt, Railway Operation. Extracts from an article by G. H. Hill in *General Electric Review*, in which high potential methods as recently developed are discussed. Ills. 2400 w. Ry & Engng Rev. June 5, 1909. No. 5370.

Electric Traction by Constant Intensity Continuous Current (Sur la Traction par Courant continu à Intensité constante). Discussion on M. Bourdel's paper on this subject. 2500 w. Bul. Soc Int des Elecns—May, 1909. No. 5720 F.

Dispatching.

See Signalling, under STREET AND ELECTRIC RAILWAYS.

Electric Traction.

On Certain Features of the Traction Problem (Sur certaines Conditions du Probléme de la Traction). J. de Traz. A discussion of the power-requirements problem. Ills. 6700 w. Bul Soc Int des Elecns—May, 1909. No. 5719 F.

Interurban.

Development of Traffic on Interurban Lines. Abstract of a paper by C. M. Cheney before Iowa Street and Interurban Ry. Assn., which discusses methods of building up business in the Middle West. 2500 w. Ry & Engng Rev—June 5, 1909. No. 5372.

See also Central Stations, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Locomotives.

Electric Locomotive for the Detroit River Tunnel. Illustrated detailed description. 2000 w. Eng News—June 24, 1909. No. 5869.

New York Central Electric Locomotives. Illustrated description of changes made in the original design which greatly increase the efficiency. 2500 w. R R Age Gaz—June 25, 1909. No. 5888.

Mexico City.

Constructional and Operating Features of the Mexico City Tramways. Describes construction, power plant, equipment and operation. Ills. Also editorial. 7000 w. Elec Ry Jour—June 5, 1909. No. 5249.

Signalling.

The Signal and Dispatching System on the Mimico Division of the Toronto & York Radial Railway. Illustrated description. 1200 w. Elec Ry Jour—June 12, 1909. No. 5357.

Single Phase.

See Railway Motors, under ELECTRICAL ENGINEERING, DYNAMOS AND MOTORS.

Subways.

The Report on a Proposed Subway System for Street Cars and Elevated Railway Trains in Chicago. Map and explanation of the proposed subways and the system of construction, with brief reference to earlier projects. Also editorial. 5000 w. Eng News—June 3, 1909. No. 5218.

Surface Contact.

The Suchostawer Stud System. Illustrated description of a surface contact system for electric traction where a skate suspended from the motor comes in contact with a series of studs. 1500 w. Engng—May 28, 1909. No. 5263 A.

Switzerland.

Choice of Frequency for the Alternating Current Railways of Switzerland (Choix de la Frequence pour la Traction par Courant alternatif des Chemins de Fer suisses). W. Kummer. A summary of the considerations which influenced the Swiss Commission to adopt a frequency of 15 periods per second. 2500 w. Bul Tech d l Suisse Rom—May 10, 1909. No. 5734 D.

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EXPLANATORY NOTE—THE ENGINEERING INDEX

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily obtainable and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Anales de la Soc. Cien. Argentina. *m.* Buenos Aires.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. d Arch Ital. *s-m.* Rome.
Applied Science. *m.* Toronto, Ont.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Bur. of Standards. *qr.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin du Lab. d'Essais. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. of Can. Min. Inst. *qr.* Montreal.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Bull. Scien. de l'Assn. des Elèves des Ecoles Spéc. *m.* Liége.
Bull. Tech. de la Suisse Romande. *s-m.* Lausanne.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *w.* Toronto and Montreal.
Canadian Mining Journal. *b-w.* Toronto.
Cassier's Magazine. *m.* New York and London.
Cement. *m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Clay Record. *s-m.* Chicago.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.

Comptes Rendus de l' Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Cornell Civil Engineer. *m.* Ithaca.
Deutsche Bauzeitung. *b-w.* Berlin.
Die Turbine. *s-m.* Berlin.
Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* New Haven, Conn.
Electrical Age. *m.* New York.
Electrical Engineer. *m.* London.
Electrical Engineering. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Journal. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Elektrische Kraftbetriebe u Bahnen. *w.* Munich.
Electrochemical and Met. Industry. *m.* N. Y.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Rundschau. *w.* Potsdam.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering and Mining Journal. *w.* New York.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Pènna. *m.* Pittsburg, U. S. A.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giesserei-Zeitung. *s-m.* Berlin.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating Mag. *m.* New York.
Ice and Cold Storage. *m.* London.
Ice and Refrigeration. *m.* New York.
Il Cemento. *s-m.* Milan.
Industrial Engineering. *m.* Pittsburg.
Industrial World. *w.* Pittsburg.
Ingegneria Ferroviaria. *s-m.* Rome.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal Franklin Institute. *m.* Philadelphia.
Jour. Ind. & Engng. Chem. *m.* Easton, Pa.
Journal Royal Inst. of Brit. Arch. *s-q.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Jour. of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *m.* Cleveland, U. S. A.
Mechanical Engineer. *w.* London.
Mechanical World. *w.* Manchester.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining World. *w.* Chicago.
Mittheilungen des Vereins für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochensch. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Power and The Engineer. *w.* New York.
Practical Engineer. *w.* London.
Pro. Am. Ins. Electrical Eng. *m.* New York.
Pro. Am. Ins. of Mining Eng. *m.* New York.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Am. Soc. Mech. Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Engrs. Soc. of Western Pennsylvania. *m.* Pittsburg.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Public Works. *qr.* London.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Age Gazette. *m.* New York.
Railway and Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revista Tech. Ind. *m.* Barcelona.
Revue d'Electrochimie et d'Electrométallurgie. *m.* Paris.
Revue de Mécanique. *m.* Paris.
Revue de Métallurgie. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
School of Mines Quarterly. *q.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
Signal Engineer. *m.* Chicago.
Soc. Belge des Elect'ns. *m.* Brussels.
Stahl und Eisen. *w.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Surveyor. *w.* London.
Technik und Wirtschaft. *m.* Berlin.
Technique Moderne. *m.* Paris.
Tramway & Railway World. *m.* London.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagen. Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.